THE OHIO JOURNAL OF SCIENCE

VOL. LII JULY, 1952 No. 4

PALEONTOLOGY AND EVOLUTION[1]

W. H. SHIDELER

Department of Geology, Miami University, Oxford, Ohio

Some especially stimulating works of paleontologists on Evolution have appeared within the past few years, two of the most recent being the great two volume "Evolution Emerging" (Gregory, 1951) and a compact little work entitled "The Dilemma of the Paleontologist," (Case, 1951).

Certain points of disagreement among evolutionary paleontologists are due to a lack of precise definitions, others to just the opposite, the attempt to make hard, fast and inflexible definitions which might be mathematically exact but cannot be maintained.

Pronouncements of various "laws" are being increasingly questioned. It is becoming clear that certain of the so-called Laws of Evolution are, as usually stated, only broad generalizations and not laws at all. One effort of this paper is to examine and restate some of these generalizations, and attempt to restate them in such a way as to take care of the various exceptions that plague the evolutionist.

In this effort I have attempted to tell something of the limitations of the field of paleontology and then go on into a discussion of general aspects of evolution from the viewpoint of the paleontologist, and especially to give attention to a rather neglected theory of evolution.

My particular field is the invertebrate life of the Paleozoic, especially the older Paleozoic. In my younger, more optimistic and probably more credulous days I rather naturally assumed that if you had four successive geological formations the first carried fossils ancestral to the second, the second carried the direct ancestors of the third, and the third had the progenitors of the fourth. But it isn't nearly as simple as that. No one of the three earlier would necessarily be ancestral to any one of the later.

Throughout geologic time the continents have been going through what may fairly enough be described as a slow motion shimmy, if the Academy remembers that early one of the modern eccentric dances. Every time our North American continent dipped down in a given direction, the epeiric seas flooded in over the depressed land as epicontinental seas, covering greater or lesser areas and usually following rather definite patterns. Depression toward the north would bring in an Arctic marine embayment and a fauna which would be quite different from such an invasion from the Gulf to the south, and both would differ from an invasion from the North Atlantic. In the older formations of Ohio just exactly these events happened, there being a rhythmic alternation between southern or Gulf faunas and northern faunas which came either from the North Atlantic or the Arctic.

[1]Presidential address at the annual meeting of the Ohio Academy of Science at Kent State University, Kent, Ohio, on April 18, 1952.

A recurrent invasion from a permanent oceanic basin, would bring back a recurrent fauna. Within such an embayment there may commonly be smaller faunal movements to and fro following shifts in the nature of the environment. In other words, migration may have as its basis either changes in the geographic pattern or in physical conditions of the environment.

We have in the recurrent faunas from a given basin a periodic view of what changes are at work upon various species. Any study of evolutionary paths must be restricted to such recurrent faunas.

Many such recurrences are known. The great Richmond invasions, so conspicuous in the Cincinnati province, are Black-River-Trenton recurrences after a lapse of probably twenty million years. Another case is the middle Ordovician Catheys-Millersburg fauna which recurs in the upper Ordovician Maysville after an interval of probably twelve million years. The lower Devonian Helderberg fauna is a recurrence of the middle Silurian Waldron fauna. In the upper Devonian are four successive recurrences of the middle Devonian Hamilton fauna. Ulrich (1911) lists five, possibly six, recurrences of the Salem or Spergen fauna.

A surprising thing about these recurrent faunas is the relatively slight amount of change between an invading species and its recurrent form. The static nature of invertebrate life is quite amazing. In the recurrent Richmond faunas 21 species are listed as being so nearly like their Black-River-Trenton ancestors as to be unable of differentiation, while it takes keen discrimination to distinguish between some of the other species. The same is true of the other cases listed.

That life, at least marine invertebrate life, is static for long periods of time is further shown by the fact that many modern mollusca go back without change to the Miocene, ten to twenty-five million years ago. Yet vertebrate life during this same lapse of time has evolved tremendously.

It is true that there have been times in the past history of the earth when evolution has apparently been quite dynamic, times when there appeared to be a veritable explosion of new types. A few of these cases do show detailed examples of very rapid and diverse evolution, as Fenton's Spirifers (Fenton, 1931) and the recurrent Tropidoleptus zones of the upper Devonian as indicated by Williams. But some of the most conspicuous examples are doubtful. Times of apparent rapid evolution are the transition from Paleozoic life to that of the Mesozoic, and that from the Mesozoic into that of the Cenozoic. They may be explained in part by the principle of adaptive radiation, but it is a question as to whether or not the real evolutionary foundation of such apparently rapid specialization had not already been built. In other words, the apparently rapid evolution of a new type may actually be due to new opportunities opening up for the rapid expansion of a specialization which had been undergoing development for a long time previously.

Actually, there is so very little that we know about the life of the older geological formations. As an example, the Cincinnatian rocks of Ohio have been a remarkably productive source of superlatively preserved examples of Ordovician fossils. Thousands of people for upwards of a century and a half have searched out specimens of the ancient life so abundantly preserved, yet new species are turning up every year, some of them of most amazing types. Yet we know nothing of any land life, though there must have been plants and primitive terrestrial arthropods. Nor do we know of any foraminifera, nor any ostracoderms, both known elsewhere. We know very little about the ancestors of the hundreds of Cincinnatian species.

Judging by the slowness with which marine invertebrate life changes, it is probably true that more than half of the fossilizable life record of the Paleozoic is lost in the unconformities between the different systems, while half of what is left is missing during the time of the unconformities within the systems, during

which times the continents were elevated and undergoing erosion while the deposition containing the record of life was off the continental limits and out along the edges of the permanent oceanic basins where it is inaccessible to us.

Thus we find that according to the record not a single Cambrian species lived beyond the break into the Ordovician, nor did a single lower Ordovician species live on into the middle Ordovician. Similarly, in Ohio, not a single species of the prolific Ordovician faunas is found above in the Silurian. When the Silurian seas came in the life was just 100% different. And faunal breaks of almost the same magnitude occur through the whole of the Paleozoic.

This does not mean that there was a complete evolution of new life during the time represented by the missing record of the unconformity. We are just beginning to appreciate the fact that while forms of life may seem of sudden origin, it is only their appearance that is sudden, for they may have had a long ancestry elsewhere where the record has been lost or is inaccessible, or it may be that they have not as yet been found.

Some decades ago the chain coral Halysites was considered to be an excellent and dependable index fossil of the Silurian. How Halysites is known from as far down as the middle Ordovician Black River, with a half dozen or more species from the upper Ordovician or Richmond.

The cystoid order Diploporita, in the light of our knowledge a few years ago, was limited to the Silurian. Now we have a form, Eumorphocystis, which carries the order Diploporita back to the Black River of the Middle Ordovician.

Several decades ago a species of the ostracode genus Aechmina was found at the top of the Richmond. To the late E. O. Ulrich, who at that time was attempting to establish the thesis that the Richmond was Silurian instead of Ordovician, this fact was highly significant, since to him Aechmina was an index genus of the Silurian and Devonian. But since Aechmina has been found down into the Stones River, through a total range of about two-thirds of the Ordovician. And there is every expectation of the genus being found still lower, since in the Stones River it is quite as distinct as in the Silurian and Devonian.

When there is so very much that we don't know and when there is so very much that might be discovered by intelligent and diligent searching in the field, one is likely to become impatient at the collectively very great but relatively sterile efforts involved in the laboratory splitting of fossil species and in some of the statistical approaches to sedimentation. Knotty points of nomenclature and priority must be settled, certainly, but it is of far greater importance to explore into the unknown.

Modern taxonomists in both Botany and Zoology have their difficulties with "splitters," but paleontologists are away ahead of them, for they may not only describe facies adaptations as species, but they may also add specific and even generic distinctions based on the degree of preservation of parts which may be preserved by silicification but are absent in the ordinary calcareous expression of the fossil.

If there has been evolution, and in the middle of this 20th century I do not see how any rational individual can deny it, then it must follow that in the paleontologic record we should find specimens intermediate between one species and another, one genus and another, one family and another, and so on. In the older Paleozoic there are relatively few such transitions, probably due to the incompleteness of the record as previously explained. But these transitions do occur and are abundantly shown in the Foraminifera, and in a lesser degree in the Bryozoa, Brachipoda, Ostracoda, etc.

This poses a special dilemma for the beginning student of Paleontology, who always expects to find rigid boundaries between different species and genera. Thus, in the bryozoan family Heterotrypidae we find four genera that, while

normally good workable groups, in one species or another each genus tends to overlap the characters of each of the other three.

Having examined some of the limitations of Paleontology with respect to Evolution, we are ready to test some of the evolutionary generalizations. In testing these it must be admitted that, because of the scantiness of the early record, and the very slow progress of evolution, the complications of different migrating faunas from different sources, and the further complications of facies adjustments, invertebrate paleontology has special weaknesses. Vertebrate Paleontology presents the very best material for the testing of evolutionary generalizations where the record is abundantly enough preserved to trace migrations more or less confidently as well as trace the evolutionary changes.

Before examining some of these generalizations we must agree upon a more exact usage of certain terms than the current usage, which has lead to considerable confusion. While very elementary, the next few statements are too often forgotten or overlooked.

Any evolution away from the primitive condition of an organism is specialization, whether that evolution be specialization by addition of something not possessed by the primitive type, or by the reduction of something present in the primitive type.

The term progressive has been usually applied to those cases where there has been a more or less steady specialization such as the steady reduction of the side toes and premolar #1 of the horse. But since these cases are retrogressive in the sense that they constitute a loss of structures which had previously been developed, they could with equal logic be called retrogressive. Specialization by reduction is applicable to the reduction or loss of toes, leg bones and premolar #1 of the horse, but the addition of new cusps beyond those of the Eohippus molars would be specialization by addition. In either case it is progressive, not meaning to infer that progressive means a change leading to a greater potential adaptability and hence greater opportunity for the organism. Whether a given specialization renders an organism more successful or less so is a criterion commonly used, but temporary success may mean ultimate failure.

It may be mentioned that with few exceptions mammalian evolution since the Paleocene has been specialization by reduction, mostly of the teeth, toes and leg bones. Most cases of specialization by addition have been in the development of horns, and in the increase in the number of teeth and phalanges in the Cetacea.

STATIC (ARRESTED) EVOLUTION

A popular belief is that life cannot stand still, it must either progress or die. Progression, in this case, is change, or what we have just defined as specialization, whether forward or backward.

Many years ago Ruedemann, in his address as president of the Paleontological Society, took as his title "The Paleontology of Arrested Evolution" (Ruedemann, 1916). It is true that refinements in classification have somewhat reduced the examples he cited. But the point remains that, whether parts of a species be split off and called varieties, subspecies or valid species, and parts of a genus be split off and called subgenera or valid genera, the morphological points of difference have usually been very small. In other words, the change from the early expression of the group to the latest is of small taxonomic value.

The geologic record is full of cases where a given group persists for a long time, and successfully, if judged by the numbers of individuals, in competition with the associated fauna. Many long lived forms seem to have lost practically all capacity to change, and have become quite static. The present day "living fossils" are striking refutations of the popular belief that life cannot be static, and these examples range from Foraminifera to Mammalia.

DOLLO'S LAW

Dollo's "Law of the Irreversibility of Evolution" has been quite generally accepted by biologists, and especially by vertebrate paleontologists. But these latter are beginning to discover what the invertebrate paleontologist has long known, which is that if the so-called Law is meant to cover evolutionary changes in size, shape, and proportion, then there are numerous exceptions to it. And, if there be exceptions, then it cannot be called a Law.

A much better statement, and one which might fairly be called a Law, would be this—An organ or part once racially lost is never racially regained.

We do have the individual return of structures which have been racially lost, but never a racial return. Here belong those cases of known atavisms, such as the zebroid coat pattern, the return of the side toes, and the return of premolar #1, the so-called wolf tooth in the modern horse. Since these appear most commonly in mongrel stock it would seem that their original disappearance was due to the gradual separation of genes where all of a certain number were required for the expression of the character. Should all be brought together again, the structure reappears.

To me one of the great mysteries of life is the way that any established group is always trying to be something different. By "trying" I do not mean consciously trying. Crinoids started out as typical Pelmatozoa with a solidly attached base on the distal end of the stalk. Many of them became free from the basal attachment but still kept trying to fasten themselves to the bottom. A half dozen different devices have been developed for anchoring the animal after it had become free.

The brachipods show the same indecision, never having decided whether to be free or attached. Whatever they are they seem always to be trying to be something else. A pedicle and pedicle opening are evolved, then in three or four different ways brachiopods attempt to close up the opening. Having freed themselves from the danger of being confined to one spot, with the attendant danger of burial in the sediments, they begin to fasten themselves down again by various cementation and spinose devices.

Among the molluscs we find the most striking cases—clams attempting to become snails (Exogyra), brachiopods (Spondylus), worms (Teredo), or corals (Rudistids). And the snails start out with a capulid type of shell, then most of them evolve a more or less high spired and compactly coiled shell, then some of those that have evolved such a shell tend to uncoil (Vermicularia) and return to primitive simplicity (Crucibulum), living more or less prosperously right along with those that have evolved compact spires. If there be any special virtue in the primitive condition, why not remain that way? Why should they evolve? If there be any special value in a tightly coiled shell, why didn't they stay that way instead of returning to primitive simplicity? And how explain why primitively simple species, specialized species, and secondarily simple species all live and thrive together through the ages and in the same environment?

The cephalopods include perhaps the best cases of exceptions to Dollo's "law," as that is usually stated. In many different lines of descent and very early in their record the primitive Nautiloidea leave the straight or slightly curved shell and evolve a more or less tightly coiled shell. But very soon (Lituitidae in the Ordovician, Ophidioceratidae in the Silurian) in at least two lines of descent the completely coiled forms begin to straighten out again, and in the Mesozoic at least two more families (Cosmoceratidae and Lytoceratidae) do the same thing. The argument applied to the gastropods applies equally well here.

THE BIOGENETIC LAW

The four so-called "laws" of Von Baer were condensed by Haeckel into the simple statement that "every animal in the course of its individual existence *tends* to recapitulate the development of the race." This has been accepted by biologists as "The Biogenetic Law." Unquestioned for the better part of a century, it has been vigorously attacked in recent years. Perhaps the heaviest attack has been by G. R. de Beer (1930) whose ideas have been more or less adopted by some paleontologists. For example, E. C. Case (1951, pp. 188–192) objects that "critical examination has shown that it can be substantiated in only a very general way." But that is precisely what is recognized in Haeckel's statement, for he states that the organism "*tends* to recapitulate," and a recapitulation is only a generalized and much condensed summary, and it doesn't follow that the recapitulation is a detailed one for each organ or part. This is a common inference among my students, and they seem downright disappointed to learn that in the human embryo gill slits, a three chambered heart and an ichthyopsidan urogenital system are not correlated with gill filaments and scales on the outer epidermis.

If the Biogenetic Law be stated in inflexible terms as "the development of each organ or part of each species through the same stages in its embryology that were passed through in the evolution of the race" as seems to be implied in some of the criticisms, then the vigorous attacks can be well justified, since there will be numerous exceptions.

Some of the critics seem to have overlooked the principle of caenogenesis, so conspicuously demonstrated in the higher orders of insects, where the early developmental stages are obscured by the extreme secondary specialization involved in the development of a larval stage, yet the highly specialized wing venation follows an excellent pattern of development according to the Biogenetic Law.

METHOD OF EVOLUTION

The problem of the method of evolution is one where paleontology can furnish especially weighty evidence in some respects, but is peculiarly weak in others. The evidence that evolution has taken place may be quite clear, but how and why that evolution happened is another matter. Thus, in the generally accepted Mutation Theory, Paleontology is quite unable to offer any evidence for or against it. A sudden specialization appears in the record, but it might be a form which had developed in some unknown way elsewhere and has migrated into the place where found, or there might be a break in the record where a slow transition is missing, or it might be a veritable mutant. There is no possible means of identifying a valid mutation.

In the last analysis both Lamarckian Evolution and Darwinian Evolution are based upon utility, upon the value to the species of some specialization. Neither could possibly explain the development of useless structures, the final disappearance of vestigial structures, and the development of the numerous cases of overspecialization that litter the geological record. Neither could explain the development of the second upper incisor of the Proboscidea beyond the point of maximum efficiency, for the same factors which would push the development of the tusks up to the point of maximum efficiency would pull back any specialization beyond that point. But the development of tusks went right on past their point of maximum value as weapons of offense and defense, or as tools used for digging up roots and tubers, and became useless because ultimately they formed great ivory loops with the points turned back toward the skull. As such they were not only useless, which means an economic waste of building material, but a continuous drain on the resources of the individual for repairs and upkeep, and another very real drain on the resources of the individual just to carry them around.

Whatever type of Evolution was responsible for the development of the tusks beyond the point of maximum efficiency, in some cases more than 50% of the whole evolution, that type must have also been responsible for the earlier evolution.

This argument applies equally well to many brachiopods and molluscs, especially cephalopods, and to spinose trilobites, over-armored dinosaurs, sabre-toothed cats, etc.

In the disappearance of vestigials a current Neo-Darwinian argument would explain it by the process of what has been called microselection of micromutations. But here we have a paradox that seems difficult to accept. The idea that microselection would eliminate a certain tiny vestigial structure, and eliminate it because it was no longer of value to the possessor, and at the same time get behind another certain tiny structure not yet developed to the point where it had any selective value, and push it on into a condition of value, seems quite inconsistent when neither has any actual value.

The possession of a vestigial tooth, toe, leg bone, or whatever may be regarded as of negative selective value because the structure is microscopically harmful to the possessor, involving a microscopic economic loss for its construction, maintenance and transportation. If this were the only structure involved in the process of selection that might be possible, but survival is not that simple. Every organ or part or superficial character possessed by an organism may be of equal or greater value than the one considered, and may vary both structurally and physiologically and at the same time. This is the old "swamping out" objection, but it is still a valid objection.

To believe that selection, micro or otherwise, could completely eliminate the vestigal lower tusks of the Mastodon-Stegodon-Archidiskodon lineage, while at the same time adding the incipient new cusps to the back of the molars, when neither had any apparent selective value, is an illustration of what I mean. The reduction and ultimate disappearance of premolar #1 of the horse lineage, while simultaneously adding incipient new structures to the other teeth, is another example, typical of many such. Which brings us up to the consideration of a fourth method of evolution, Orthogenesis.

ORTHOGENESIS

This explanation is not held in very good repute by evolutionists, and goes by a variety of names, but admitting of certain variations in the mechanism, these terms may fairly enough be lumped together as Orthogenesis. Some of these synonyms or related terms are aristogenesis, autogenesis, bathmism, elan vital, entelechy, inner principle of progressive development, nomogenesis, ortho-selection, rectigradation, and vitalism. Orthogenesis covers all those numerous cases where a certain specialization begins and progresses more or less steadily in a given direction to a maximum of change. Such specializations continue through shifting environments for tens or scores of millions of years, apparently largely independently of both environment and selection so far as the motivating causes are concerned.

Illustrations usually given are the evolution of the horse, elephant, camel, etc., but many other more or less well-developed cases are known in both vertebrate and invertebrate paleontology.

The objection has been raised that any detailed line of descent will appear to be orthogenetic whatever may have been the cause of the progressive change. Whether or not it really is and how to tell the real from the spurious is a question. Possible criteria testing such cases would be the following.

1—The steady reduction of vestigials, as previously discussed.

2—Overspecialization, as previously discussed.

3—Evolution of useless characters.

4—Evolution persisting along a straight line through changing environments.
5—The same modification appearing in closely related pedigrees but at different times and under different environmental conditions.

The evidence presented for the disappearance of vestigials is all evidence in support of orthogenesis. To examine vestigials a bit further, the horse's premolar #1 can be matched by hundreds of similar examples. The human molar #3 or wisdom tooth is an excellent example of what I mean. It is going, and has been going since at least the close of the Pliocene which was conservatively about a million years ago. The smaller, less well enameled molar #3 is one of the dependable characters separating the Simiidae from the Hominidae. And it is going, just as did the premolar #1 of the horse. It is a ghastly thought to consider that the horse took the better part of 50 million years to completely lose his first premolar, and then think ahead to the future of the human species.

But why is the third molar going? In all types of environment from arctic ice to the tropical rain forests, in deserts, plains and mountains, from the Esquimaux and Australian to the most developed and sophisticated peoples, molar #3 is going. In skulls of prehistoric Indians and Mound Builders, some of whom had used their teeth until they must have been worn down almost to the gum, the wisdom teeth are reduced. It doesn't seem reasonable to believe that micromutants, or by whatever name they may be called, would be of selective value in reducing the teeth and so conserving building material when it would be more logical that selection pressure would be in the opposite direction, with greater value in the strengthening of the wisdom teeth so as to avoid many of the liabilities of having them as they are. There is to be sure the problem of impaction due to the shortening of the human jaw, but that is another example of Orthogenesis. Early Homo sapiens, as well as races living under primitive conditions where the teeth and jaws are much used, all show some shortening.

If all of these modifications have been by mutations, the separate mutations have been so tiny as to be individually unrecognizable. This could have been, since cumulative mutations would be orthogenetic mutations, there being nothing incompatible between Mutation and Orthogenesis. Cumulative mutations are of the types shown by improved varieties of sweet peas, dahlias, Shasta daisies, etc., among the plants, and pigeons and ostriches among the animals.

One of the most convincing proofs of Evolution is to be found in the field of Comparative Anatomy, using as evidence the urogenital systems. Either we have the replacement of the primitive pronephric urogenital system of the primitive fish by a new mesonephric system typical of the Ichthyopsida, and that in turn replaced by the metanephric system of reptiles and mammals, or else the whole logical argument for Evolution in the field of Comparative Anatomy is wrong. And either exactly this same order of succession, with each system having its own detailed structures, is proven by the embryological history of the urogenital systems, or else the whole idea expressed in the Biogenetic Law is wrong. But if these arguments for the fact of Evolution in these fields of Comparative Anatomy and Embryology are valid, then it must follow that at least the metanephric system is a brand new set of excretory tubules with a brand new pair of excretory ducts, the ureters. Some way there must have been an evolution through the early non-functional stages of the system. Being non-functional there was no selective value inherent in their presence. Neither Lamarckism nor Darwinism could have been instrumental in the development of these structures to the point where they could have been of positive functional value to their possessors.

A very similar argument is afforded in the same two fields by the heart. The argument for Comparative Anatomy, and as checked in the field of Embryology, is that in the beginning of Vertebrate Evolution the heart was a simple tube modified into contractile chambers, the sinus venosus collecting the blood, forcing

it forward into the single auricle, and it in turn into the single ventricle. In evolving from the lower fish to the higher fish and Amphibia the auricle became divided into two. Why does it become so divided? Potentially it is a most important forward step, but so long as both oxygenated and unoxygenated bloods are completely mixed in the single ventricle, where is there any selective value? If of no selective value, why did it evolve? Specialization continued through the partition of the single ventricle into two, the division being quite incomplete in some reptiles and complete in others and in mammals. But I submit that until the division of the ventricle is half complete there can be no appreciable selective value. Which means that 75% of the whole evolution of a two-chambered heart into a four-chambered one has been completed before there can be any appreciable selective value. And if 75% of this evolution is due to something other than Lamarckian or Darwinian Evolution, it seems reasonable to assume that the final 25% or so of Evolution would be due to the same method as the rest of it. As before stated, this evolution could be by Mutation, but if so it is orthogenetic mutation.

Many instances of Orthogenesis among Foraminifera are listed by Galloway (1933), and these are quite like my own observations upon Bryozoa and Brachiopoda in that specializations show no evidence of having been initiated by environmental stimuli activating latent tendencies, since the specializations in that case should occur simultaneously in different related lines of descent. Actually a given specialization may begin in separate but related genealogies at different times, in different places, and under different environmental conditions as far as these may be judged by the character of the sediments and the nature of the associated life. This is particularly true in such cases as in the brachiopod genus Spirifer, using that term in the old broad sense, where at least five lines of descent, now mostly known by subgeneric terms, have all attempted at one time or another to become spinose.

To include this type of specialization would expand the definition of Orthogenesis to include not only the cases where a co-ordinated group of specializations progresses through geological time, as in the evolution of the horse, and those cases of single specializations, but also those cases just mentioned where there is a tendency for the same specialization to appear in separate but related genealogies at different times, in different places, and under different environmental conditions.

These specializations need not be purely linear and isolated, but may show digressions from the main line as in the camels, elephants, horses, etc., each digression being possibly orthogenetic in its nature.

At various times H. F. Osborn has stressed the invariable nature of these straight lines as he observed them in fossil vertebrates. But in invertebrates, especially brachiopods, my observation has been that such development has not been along the narrow, straight, undeviating path implied by critics and protagonists alike. While the general course was more or less straight, along that course we find at any given time a quite wide range of variability of a given character.

To me the progression of life through the ages has been quite analogous to that of a moving herd of cattle on the open range. Individuals may zig-zag from one side to another, there may be a decided milling around, separate groups may leave and go off on their own tangents, yet the movement of the herd as a whole is definitely in a given direction.

I am not even implying in this simile that there is a driver behind this hypothetical herd, nor behind these progressive specializations which are largely independent of the environment, and are controlled by it only when fairly well developed.

But we may ask, just what *is* behind these cases of Orthogenesis? Is there a driver behind the moving herd, an Intelligent Design behind evolving life? Or

is there an inner urge of some kind present? In the herd we can understand the origin of such an urge in hunger, thirst, protection, etc. In life's evolution the origin of such a progression, the cause of Orthogenesis, is a mystery.

There does seem to be something within the lineage and within the individual organism that is struggling for expression, but of it's nature and its origin, and just how that urge got into the germ plasm, we know nothing, for here we depart from science and enter the field of purely speculative metaphysical philosophy.

Scientists have been hypersensitive with respect to any idea of a teleological influence, of an Intelligent Design, behind the development we call Orthogenesis, and apparently this has in part explained why they have been so slow to accept the challenge of the implications involved. The reason for this reluctance is to be found in the practically complete stagnation of science from the death of Galen, 200 A. D. to the renaissance of Science in 1543, during which period of the Dark Ages, the Age of Scholasticism, and even later, it was assumed that everything worth knowing had been known to the ancient prophets, the Greek philosophers, and the early Christian fathers.

However, it is not necessary for Science to adopt a teleological explanation. If that doesn't have an appeal there is always the possibility of following the dictum of the unknown writer of the ancient medical school of Hippocrates at Cos. Writing upon epilepsy about 200 B. C. he said, "But if they called everything divine merely because they did not understand it, why, there would be no end of divine things. . . . In nature all things are alike in this, that they can all be traced to preceding causes." In other words, one can leave it an open question, as did H. F. Osborn when he once called it "the great unknown factor in Evolution."

It is true that if we collect one kind of evidence we can quite logically justify a belief in an Intelligent Design. If we collect another type of evidence we can justify the opposite. However, if we put all the evidence together, as a scientist must, these two collections cancel each other very nicely, and we are left where we started. But we still have the fact of Orthogenesis.

BIBLIOGRAPHY

Beer, G. R. de, 1930. Embryology and evolution. Oxford, Clarendon Press.
Case, E. C., 1951. The dilemma of the Paleontologist. Contrib. from the Mus. of Paleon., Univ. of Mich., 9: 173–215.
Fenton, C. L., Evolution of the genus Spirifer. Wagner Free Instit. of Science, Vol. II.
Galloway, J. J. 1933. A manual of Foraminifera. Principia Press, Bloomington, Indiana.
Gregory, W. K., 1951. Evolution emerging. Macmillan.
Rudemann, Adolph, 1916. N. Y. State Mus., Bull. 196: 167–134.
Ulrich, E. O., 1911. Revision of the Paleozoic systems. Geol. Soc. Amer., Bull. 22: 301.
Williams, H. S. 1913. Recurrent Tropidoleptus Zones of the Upper Devonian in New York. U. S. Geol. Surv. Prof. Paper 79.

CHANGE IN BOOK REVIEW EDITOR

Dr. Curtis M. Wilson of the University of Toledo has been Book Review Editor of the Ohio Journal of Science since May, 1950. He has recently accepted a position in Oregon and so has resigned from his position with the Journal, which loses thereby an enthusiastic friend and energetic worker. Dr. Frank W. Fisk has accepted a new position of Book Review and Associate Editor, beginning with this number. Requests for books for review, correspondence about book reviews, and books for review should be addressed to Dr. F. W. Fisk, Book Review Editor, Botany and Zoology Building, Ohio State University, Columbus 10, Ohio.

CARBON DIOXIDE GRADIENTS IN A BEECH FOREST IN CENTRAL OHIO[1]

H. R. DE SELM

Department of Botany and Plant Pathology, The Ohio State University, Columbus 10

Knowledge of the physical environment of biotic communities is not complete without knowledge of the carbon dioxide relations of such complexes. The present study deals with the carbon dioxide relations of a beech forest in central Ohio during late spring and early summer, 1950.

An attempt has been made to determine the daily fluctuations in concentration gradients and to suggest factors influencing these gradients. Such data not only supplement microclimatological studies such as those of Wolfe, Wareham, and Scofield (1949) but results here obtained also help to show the dynamic relationships of the integral parts of the forest habitat and how these parts are associated one with another. The true nature of these equilibria can be studied only where remnants of relatively undisturbed vegetation remain. The present study was carried out in such an area.

LOCATION AND DESCRIPTION OF THE PROBLEM AREA

The problem area is located at the western edge of a level to gently undulating Late Wisconsin till plain, between Blacklick Creek and South Fork of the Licking River. It is in northwestern Etna Township, Sec. 3, T 16 N, R 20 N, Licking County, as noted on the Thurston, Ohio U.S.G.S. quadrangle.

Elevation varies from about 1080 feet, along a slight ground swell at the western edge of the forest, to 1070 feet along an intermittent, south-flowing stream which bisects the forest. The terrain thus slopes gently east and south.

Two soil types form a mosaic in the problem area. They are Marengo silty clay loam and Bennington silt loam, both derived from glacial drift largely composed of sandstones and shales which occur in a north-south belt in the region (Stauffer *et al.*, 1911). The former develops on flat upland areas having poor internal drainage and abundant organic matter. Internal drainage of Bennington is better than that of Marengo although accumulation of organic matter is less. It occurs on undulating uplands (Wildermuth *et al.*, 1938) in the problem area chiefly on the swell at the west edge of the forest.

Beech (*Fagus grandifolia*)[2], constituting over half of the canopy, dominates the vegetation in the vicinity of the sampling area. Species of secondary importance are:

Ulmus americana
Quercus rubra
Fraxinus americana
Acer saccharum
Prunus serotina

Layer societies are those characteristic of swamp forest, in late stages of development, and include:

Small trees

Asimina triloba
Carpinus caroliniana
Carya cordiformis
(saplings)
Crataegus spp.
Ostrya virginiana

[1]Department publication 531. Personal acknowledgments are made to John N. Wolfe.
[2]The nomenclature followed here is essentially that of *Gray's Manual* (Fernald, 1950).

Shrubs and vines

Euonymus obovatus
Lindera benzoin
Menispermum canadense
Parthenocissus quinquefolia
Rhus radicans
Sambucus canadensis
Smilax glauca
Vitis spp.

Herbs

Actea pachypoda
Anemone quinquefolia
Arisaema atrorubens
Cardamine douglassii
C. pensylvanica
Carex spp.
Circea quadrisulcata
Claytonia virginica
Cryptotaenia canadensis
Dentaria laciniata
Dicentra cucullaria
Erythronium albidum
E. americanum
Floerkea proserpinacoides
Galium aparine
G. concinnum
G. tinctorium
G. triflorum
Geum canadensis
G. vernum
Gratiola neglecta
Impatiens capensis
I. pallida
Mimulus ringens
Mitchella repens
Onoclea sensibilis
Ozmorhiza longistylis
Phlox divaricata
Phryma leptostachya
Poa pretensis
Podophyllum peltatum
Polemonium reptans
Polygonatum canaliculatum
Ranunculus abortivus
Sanguinaria canadensis
Sanicula canadensis
Smilacina racemosa
Trillium grandiflorum
T. sessile
Urtica dioica
Veronica officinalis
Viola pensylvanica
V. papilionacea

On a slight rise at the west edge of the tract, the dominant vegetation is Beech-Sugar Maple.

Known disturbances of the vegetation since settlement are: (1) A strip of second growth 45–80 yards wide lies along the south border of the forest. At its closest point it is 150 yards from the sampling area. (2) In 1922 most of the ash was removed from the stand.[3] (3) Cattle from an adjoining pasture have been allowed to enter the forest since the early nineteen hundreds.[3] Effects of pasturing are slight although detectable in the Beech-Sugar Maple area.

EQUIPMENT AND METHODS

Air samples of not less than 20 liters[4] were drawn at the rate of 40 liters per hour into four Sargent Wet Meters. The air was then pulled, by means of an electrically operated vacuum pump, into scrubber towers of the Heinecke-Hoffman (1933) type as modified by Böhning (1949) who has described the method in detail. Samples were taken 60 yards from the north edge and 100 yards from the west edge of the forest through four one-eighth inch ID plastic tubes, each at a different level above the leaf litter: three inches, three feet, 30 feet, and 41 feet. The last-named tube lay just below the lower limbs of the canopy. The tubes were connected directly to the Wet Test Meters.

Relative humidity was measured with a sling psychrometer, barometric pressure with a Taylor aneroid barometer.

Determinations were begun on April 29, 1950, and continued at more or less

[3]Personal conversation with Mr. and Mrs. H. G. Henderlick. Mr. Henderlick's father formerly owned the land.

[4]All volumes reduced to 0° C, 760 mm Hg.

regular intervals until May 25. From June 14 through June 23, and from June 29 through July 3, determinations were made at one to four hour intervals during daylight hours. Measurements were also made at two to three hour intervals between 9 P.M., June 12, and 8 A.M., June 13.

REVIEW OF THE LITERATURE

The nature of forest carbon dioxide gradients have been determined in some detail by many workers. In general, concentrations have been found to be greatest near the forest floor and show a constant decrease to some point in (Romell, 1928), or above the canopy (Gut, 1929). High concentrations nearest the substrate are attributed to diffusion of carbon dioxide from the soil, where respiratory activities of roots and micro-organisms produce considerable amounts.

Feher (1927) considered the greatest production of soil carbon dioxide to come primarily from aerobic cellulose-decomposing bacteria. Turpin (1920) found that a larger proportion of soil carbon dioxide was that released from the roots of young, rapidly growing crop plants than from soil micro-organisms. Romell (1922) stated that there is complete removal of soil air to a depth of 20 cm every hour and attributes such movement to diffusion. Such a phenomenon accounts for the evolution of 0.2–0.7 grams of carbon dioxide per square meter per hour from the soil (Romell, 1932). It then diffuses or is dispersed by wind currents to higher levels.

Meinecke (1927) found, contrary to the reports of other workers, that during daylight hours, the concentration above the canopy may be less than in the canopy although not as high as below the canopy. He assumed that most of the photosynthetic carbon dioxide has its origin in the respiratory activities of roots and micro-organisms of the soil. In this connection Lundegardh (1921), using data of his own and some of Ebermayer, calculated that 60 percent of the photosynthetic carbon dioxide of European beech forests is that which emanates from the soil.

Fuller (1948) reported that carbon dioxide gradients are usually steepest in the eight centimeters closest to the substrate. Feher (1927) found the zone of greatest concentration below four meters.

Gut (1929) measured concentrations at several levels from near the surface to 28 meters in various forests near Zurick. He found that, daily, the concentrations decreased until late morning after which there was begun a slight rise which continued until 2 A.M. the next morning. The drop in concentration was attributed to active photosynthesis in the forest while the subsequent rise was considered due to diffusion of carbon dioxide from soil organs and micro-organisms under less active photosynthetic conditions. On certain afternoons in a deciduous forest sharp increases in concentration at all levels were found. These might be explained by the accumulation of end products of photosynthesis in the leaves to the extent that the subsequent rate of photosynthesis in the leaves is reduced (Braun-Blanquet, 1932; Gut, 1929).

Night concentrations are high, being also influenced by respiration of aerial plant organs. Gut (1939) attributed decreases in concentration before sunrise to ultraviolet-induced photosynthesis. Stocker (1935) attributed low night concentrations to combination of carbon dioxide with "Kuticular Excretion der Blätter" of certain tropical forest species at Tjibodas, Java. Other tropical studies have been made (Evans, 1939; von Faber, 1935; McLean, 1919).

The lowest and most variable concentrations of forest carbon dioxide have been reported in spring while the highest concentrations are usually reached in autumn (Gut, 1929). Meinecke (1927) found concentrations increasing from April through July following which there was a gradual decline. Russell and Appleyard (1915) considered temperature the chief factor governing carbon dioxide production in the soil from November to May. Soil moisture is limiting the rest of the year. They found maximum production during late spring and autumn.

Feher and Sommer (1928) concurred and stated that during winter, forest carbon dioxide concentrations sink to the level of the general atmosphere.

Lundegardh (1921, 1924, 1931) considered the chief factors influencing the carbon dioxide concentration as being the effect of season, time of day, wind strength, haze, pressure and temperature upon respiration of roots and soil microorganisms, and respiratory and photosynthetic activity of surface vegetation. Affecting the first may be added, availability of mineral nutrients, soil texture and aggregation, moisture and aeration, organic matter, and pH (see Feher, 1927). These factors are agreed upon by most authors though data are sketchy on the relative importance of each.

Certain plant communities have been compared with respect to carbon dioxide concentration. In separate Bavarian forests of beech and pine, Ebermayer and Swappach (1878) and Ebermayer (1879, 1885) made the first attempts to measure carbon dioxide concentrations in forest communities. In the latter paper, Ebermayer reported considerably higher concentrations in a beech forest than those in pine. In spite of these apparent fluctuations he concluded that forest carbon dioxide concentrations were not unlike those of other air and, according to Gut (1929), that conclusion materially reduced the subsequent amount of research in this field. Research of the nineteenth century has been summarized by Letts and Blake (1900).

Some communities have been compared at the Hallands Vädëre Ecological Station with respect to carbon dioxide concentrations present. Johannson (1926) compared meadow and swamp communities. Others have found that concentrations averaged lower in alder than in pine or beech stands (Feher, 1927). The highest concentrations were found in a beech stand while pine was intermediate in this respect (Feher, 1927; Lundegardh, 1921).

Comparatively low concentrations have been found in forests with poorly developed layer societies as compared to multi-layered selection forests. These low concentrations are attributed to good air mixing in the former type (Gut, 1938; Meinecke, 1927). The latter author suggested that border and underplantings may reduce wind velocities enough to allow more effective utilization of carbon dioxide produced in the soils of the stand.

Harder *et al.* (1931) found fluctuations considerable even on the Sahara Desert.

A forest-grassland comparison has been made by Fuller (1948) in Illinois. He attributed higher concentrations in forest than in grassland areas to more sluggish and less extensive air movement in the former.

The effect of carbon dioxide concentration on the distribution of plant species has been little discussed in the literature. Lundegardh (1921) stated that the increased carbon dioxide supply near the ground is an important factor necessary for the existence of shade flora, *e.g. Oxalis acetosella*, in that it enables the plant to make more efficient use of sunflecks of high intensity which may cross their leaves. Such species are the so-called "carbon dioxide plants" and are said to be found on soils from which the rate of carbon dioxide evolution is high. McComb and Loomis (1944) suggested that if upland trees have roots less tolerant of carbon dioxide than prairie species, this might help to explain the failure of trees to invade grasslands, where root respiration and decay probably create a relatively high concentration. Decker (1947) stated that the diffusion of carbon dioxide into a leaf is a function of pressure rather than concentration and the pressure of carbon dioxide in the atmosphere varies directly as the total atmospheric pressure. He suggested the possible importance of carbon dioxide pressure as a factor in the altitudinal distribution of species. Daubenmire (1943) noted that high altitude is accompanied by low atmospheric pressure and a subsequent low partial pressure of carbon dioxide "which even at low altitudes is generally a limiting factor in photosynthesis." At least in the lower layer societies, light intensity is usually considered the limiting factor in photosynthesis in the forest of the type in which

the writer's study was conducted. Wilson (1948) found carbon dioxide concentrations 20 to 25 percent higher on foggy than on clear mornings. The increased concentration was paralleled by an increase in apparent photosynthetic activity of plants. He observes that these facts may have an application to those regions where maximum plant growth is associated with the prevalence of fog.

RESULTS AND DISCUSSION

Spring Gradients

Few data regarding hourly fluctuations of carbon dioxide gradients before May 18, when the canopy closed, are available. Determinations made one hour apart however, usually exhibit a gradient of decreasing concentration from three inches to 41 feet.

Moreover, considerably more variability is exhibited before than after canopy closure, *e.g.* the morning of May 8 was preceded by minimum temperatures of 1° C at 20 feet and 4° C under the leaf litter.[5] Such low temperatures may have reduced the rates of respiration of soil micro-organisms, roots, and surface vegetation to a degree low enough to account for a concentration of 0.025 at three inches and 0.023 volume percent at higher levels. These are minimum concentrations found for the spring season. The effect of a high water table upon the metabolic activity of soil microflora must also have been considerable. It is noted that pools of water persisted on the forest floor until the end of April.

Maximum concentrations for the spring season at three inches is 0.04 volume percent; three and 30 feet, 0.034; and 41 feet, 0.031. Spring concentrations average, 8 A.M. to 6:30 P.M., 0.030 volume percent.

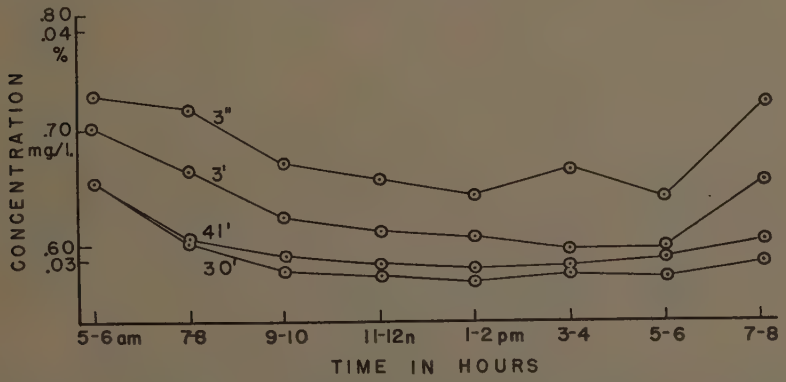


FIGURE 1. Average early summer gradients. In the vertical axis, carbon dioxide concentrations are given in percent and in mg/liter. Points determined by averaging values for 5 and 6 A. M., 7 and 8 A. M., etc.

Summer Gradients

Determinations made after May 18 were simultaneous at the four levels previously described. The data have been averaged and are represented diagramatically in figure 1. While averaging such values may obscure many phenomena, especially maximum and minimum concentrations, the general relation of time and strata to concentration is apparent by inspection.

[5]Christy (1952) has described certain temperature phenomena in this forest, April through December, 1950.

As in spring, concentrations at three inches were higher than at any other level. This is undoubtedly due to its proximity to the soil. Also important is the fact that herbs and shrubs at this level reduce wind velocities and mixing of carbon dioxide with air at higher levels does not occur. The slight ground swell to the west of the station also shelters the three inch level at this point when winds are from that direction (during about 60 percent of the sampling periods).

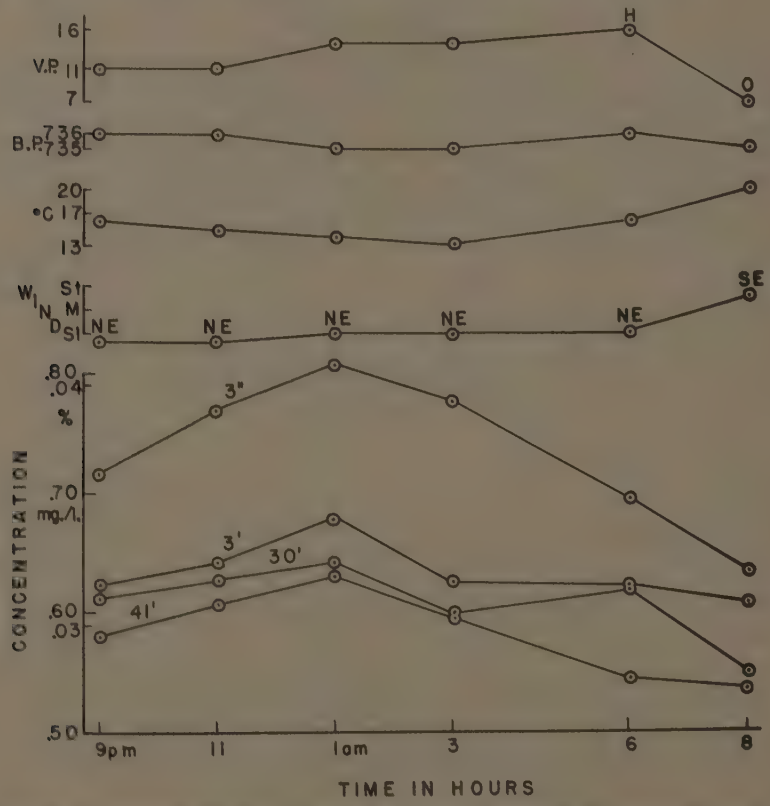


FIGURE 2. Night concentrations of carbon dioxide. In this figure, and those that follow, V.P. refers to vapor pressure in mm of Hg; over the vapor pressure curve are symbols indicating character of the atmosphere: O=overcast; H=hazy; no letter=clear. Also indicated: B.P. for barometric pressure; °C=temperature at three feet; wind: M=moderate, St=strong, Sl=slight.

The decline in concentration until early afternoon is probably due to better air mixing associated with higher wind velocities than those in the morning, increased number and strength of convection currents caused by heating of the substrate by sunflecks, and photosynthesis in the forest and surrounding areas. Increases in concentration in the late afternoon parallel lessened photosynthetic activity though emanation of carbon dioxide from the soil is undiminished.

As indicated by the high concentrations in the early morning and late evening, those at night are usually higher than during the day (fig. 2).

Concentrations at the three foot level are always lower than at three inches, though the daily trend is the same. The effect of greater air mixing is evident.

As has been stated, the sampling tubes were about 100 yards from the west edge of the forest. Pasturing has somewhat reduced the number of shrubs and small trees between the forest edge and the intake tubes, hence wind at that level, from the west and southwest had little to impede its progress into the forest. While the three inch and three foot levels were somewhat sheltered, the 30 foot level was exposed, on over half of the measurements, to a current of well-mixed "outside air." This fact may account for the low concentrations indicated in figure 1. In an unbroken forest this probably does not occur.

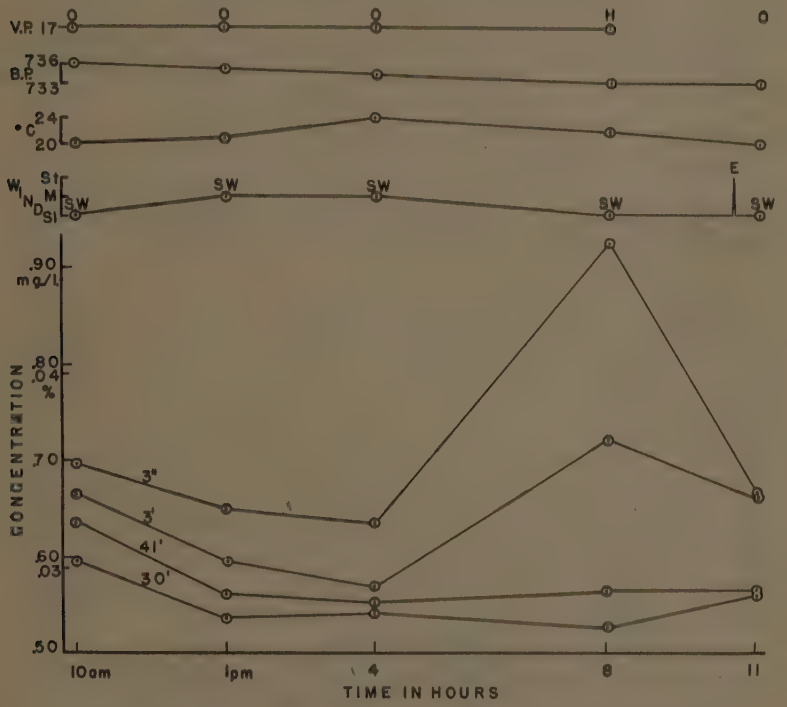


FIGURE 3. Effect of wind on carbon dioxide gradients at lower levels.

The intake at the 41 foot level, located just below the lower branches of the canopy, is thus more sheltered than the 30 foot level. Concentrations at this level were usually not lower than those of the "outside air" as reported in the canopy by other authors. Daily patterns of concentrations are closely associated with the 30 foot level, though occasionally they are more nearly like those at three feet (fig. 4).

The average summer concentration, 5 A.M. to 8 P.M. at three inches is 0.035 volume percent; three feet, 0.032; 30 feet, 0.030; and at 41 feet, 0.031. Discounting strata, the total average daytime concentration value is 0.032. The daytime minimum and maximum concentrations at three inches are 0.029 and 0.047 volume percent respectively; three feet, 0.0275 and 0.040; 30 feet, 0.026 and 0.036; and at

41 feet, 0.027 and 0.036. Most minimums occurred after 1 P.M., while most maximum concentrations occurred between 5 and 6 A.M.

The effect of the respiration of plant organs and micro-organisms at night is demonstrated in figure 2. The measurement of gradients was begun at 9 P.M., June 13, and ended at 8 A.M., June 14. During this interval concentrations at all levels increased until 1 A.M. following which there was a decrease which continued until determinations were ended. The increase is attributed to respiratory activity

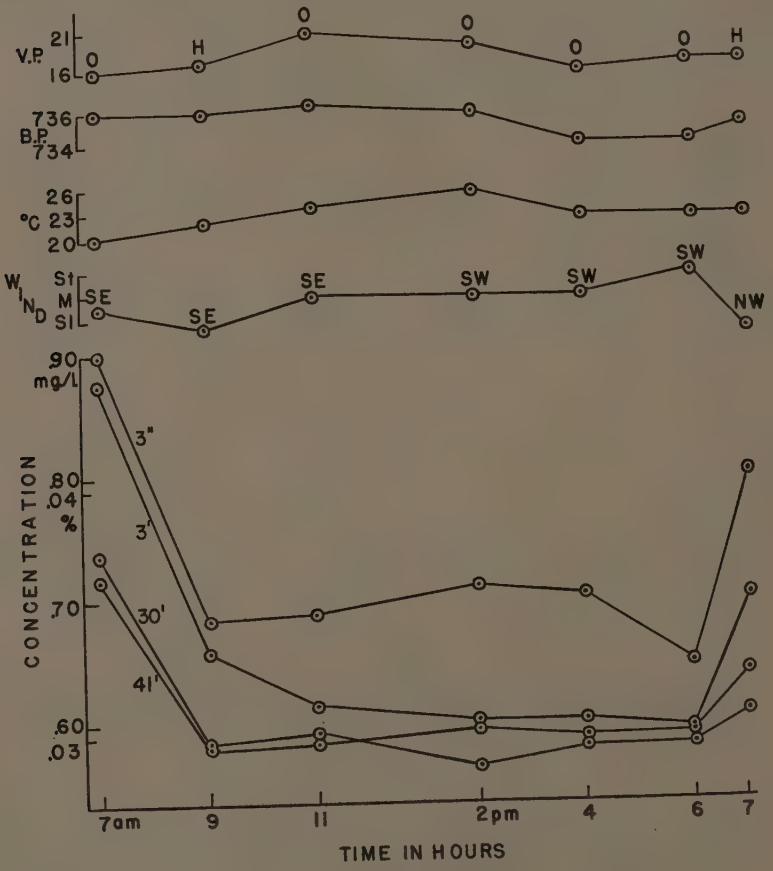


FIGURE 4. Effect of wind direction and velocity on carbon dioxide gradients.

of plant cells both in and above the substrate. The decline in concentration was preceded by a slight increase in wind velocity which initiated replacement of forest air with that from the outside in which the concentration was lower. This replacement proceeded at a faster rate than the concentration was rebuilt by respiration.

It is noted that the gradient from soil to canopy is constant, that is, the 30 foot level had a higher concentration than that at 41 feet. This is thought to be a

consequence of poorer air mixing at 30 than at 41 feet due to the reduction of wind velocities by a well developed understory characteristic of the northeastern part of this stand.

Other workers have attributed high concentrations in the canopy during the night to the large respiring surface there. The gradual decline in the difference in concentration between the 30 and 41 foot levels may be due to the proximity of the higher sampling inlet to the canopy.

By 8 A.M. light intensity was only 40 foot candles at a point five inches above the substrate. Though intensities were perhaps several times greater in the canopy,

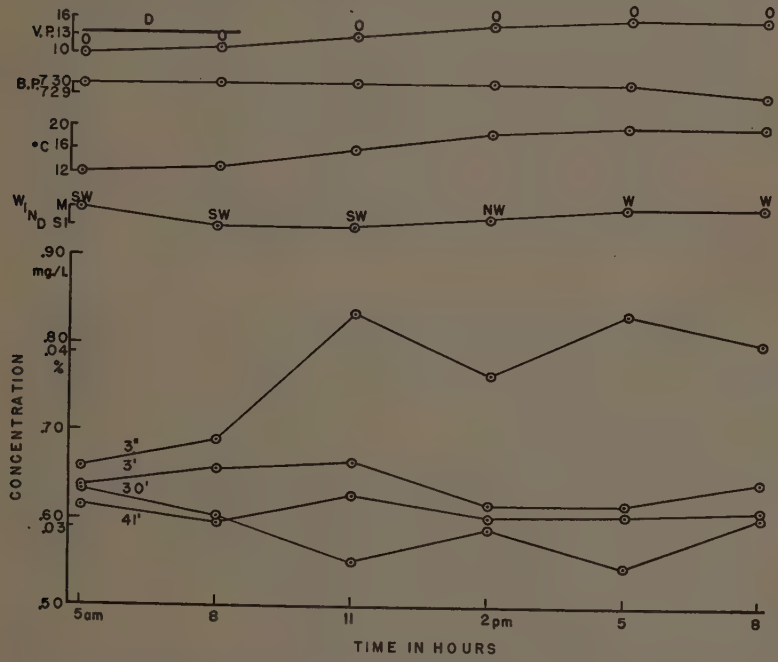


FIGURE 5. Effect of rain on carbon dioxide gradients. D=drizzle type rain; underscore indicates its duration.

it is doubtful if even the compensation point had been reached in beech until after 8 A.M.

Figure 3 shows the effect of a single gust of wind on the carbon dioxide concentration at the three inch and three foot levels at night. During the day the concentrations followed the usual downward trend until at least 4 P.M. Between 4 and 8 P.M., wind velocities declined, photosynthesis had become negligible and concentrations at the lower levels had reached sizeable proportions. At 10:30 P.M., however, the air was replaced with air from outside the forest containing a considerably lower concentration. This replacement was accomplished by a strong northeasterly wind of only a minute's duration.

June 15 exemplifies a day when respiration by soil organs and micro-organisms was intensive but moderate southeast and southwest winds reduced concentrations at higher levels (fig. 4). Until noon the gradient is constant and the concentration

at the 30 foot level did not drop below that at 41 feet until the wind direction had shifted from southeast to southwest. To the southeast, as to the northeast, there is a considerable area of dense vegetation, well developed in all layer societies. The impedance of wind speed at 30 feet by vegetation is apparent.

The 5 A.M. measurements on June 19 (fig. 5) were preceded by gusty south winds accompanied by rain. Again the gradient was constant under the influence of wind direction. With a shift to the southwest, however, the typical inversion appeared, was partially destroyed by northwest winds, and reappeared with westerlies. The formation of constant gradients under the influence of northwest winds was a regular occurrence and related not only to the density of the forest vegetation but also the presence of overgrown fencerows in that direction.

The close grouping of concentrations at 5 A.M. accompanies good mixing associated with moderate winds.

Following rain, the concentration of carbon dioxide is generally increased. The explanations of such a phenomenon are various: replacement of soil air with water, increased activity of soil micro-organisms under the accelerating effect of moisture or dissolved oxygen, and accompanying low pressures "sucking out" the soil air. Early morning determinations on June 16 were taken during a thunderstorm. The average concentration for the day was 0.034 while at the three inch level it was 0.038. Individual measurements were as much as 20 percent higher than average for that two hour period. Such high concentrations are not evident the next day.

SUMMARY

The concentration of atmospheric carbon dioxide effects the rates of both photosynthesis and respiration in green plants. Since the relative rates of these processes may determine whether or not a plant survives in an environment, a study of the factors influencing these rates is necessary for an understanding of the habitat and its biota.

Indeed some relationships are reciprocal: the activities of plants are not only in part controlled by their environment, but they control or at least modify that environment. These environmental relationships are cyclic and interdependent.

The ecological relations of the daily periodicity of atmospheric carbon dioxide gradients in spring and early summer found as a result of this study are:

1. Average spring and summer concentrations (8 A.M. to 6:30 P.M.) are 0.030 and 0.031 volume percent respectively.
2. Spring concentrations at all levels exhibit greater day to day variation than do those of summer.
3. Concentrations in spring at all levels are usually lower than those in summer.
4. Spring gradients are regularly constant from soil to the unopened canopy.
5. Average summer concentration (5 A.M. to 8 P.M.) is 0.032 volume percent.
6. Although gradients are not always constant, much of the photosynthetic carbon dioxide in summer also emanates from the soil level.
7. Average summer daytime concentrations are: at three inches, 0.035 volume percent; three feet, 0.032; 30 feet, 0.030; 41 feet, 0.031.
8. Absolute maximum and minimum concentrations (5 A.M. to 8 P.M.) during early summer at three inches are 0.047 and 0.029 volume percent respectively; at three feet, 0.040 and 0.0275; at 30 feet, 0.036 and 0.026; and at 41 feet, 0.036 and 0.027.
9. Wind direction, *per se*, has no apparent effect on carbon dioxide concentration. Its effect in summer lies in its relation to air mixing especially at the 30 and 41 foot levels. Winds from the west and southwest result here in a reduction in concentration at the 30 foot level. Constant gradients from three inches to 41 feet are formed when winds are from other directions.

10. Rain increases the carbon dioxide concentration. These increases are not evident the following day.

11. Early summer concentrations are usually higher during the early morning, and late afternoon and evening hours than during other parts of the day. These hourly differences are probably due to increased wind movement and higher rates of photosynthesis of adjacent vegetation accompanying increased light intensity.

12. Concentrations at night are higher than those during the day unless influenced by considerable air mixing.

13. Maximum rates of change in concentrations usually occur in the early morning and late evening. Minimum rates occur in the late morning and afternoon.

14. Herbs, shrubs, and saplings are subject to higher concentrations than are individuals with leaves at higher levels.

LITERATURE CITED

Böhning, R. H. 1949. Time course of photosynthesis in apple leaves exposed to continuous illumination. Plant Phys., 24: 222–240.

Braun-Blanquet, J. 1932. Plant sociology (Trans. Fuller and Conrad). McGraw-Hill, New York.

Christy, H. 1952. Vertical temperature gradients in a beech forest in central Ohio. Ohio Jour. Sci., 52: 199–209.

Daubenmire, R. F. 1943. Vegetational zonation in the Rocky Mountains. Bot. Rev. 9: 325–393.

Decker, J. P. 1947. The effect of air supply on apparent photosynthesis. Plant Phys., 22: 561–571.

Ebermayer, E. 1879. Mitteilungen über Kohlensäuregehalt eines bewaldeten und nicht-bewaldenten Bodens. Landwirtschaftlichen Versuchs-Stationer. 23: 64.

———. 1885. Die Beschaffenheit der Waldluft. Akad. Sitzber, München, 15: 299–304.

——— and **Swappach.** 1878. Mitteilungen über den Kohlensäuregehalt der Waldluft und des Waldbodens im Vergleich zu dem einer nicht bewaldeten Fläche. Biederman's Centralblatt. 7: 644–648.

Evans, G. C. 1939. Ecological studies on the rain forest of Southern Nigeria. I. The atmospheric environmental conditions. Jour. Ecology, 27: 436–482.

Feher, D. 1927. Untersuchen über die Kohlenstoffernährung des Waldes. Flora, 21: 316–333.

——— and **G. Sommer.** 1928. Untersuchen über die Kohlenstoffernährung des Waldes II. Biochem. Zeit., 199: 253–271.

Fernald, M. L. 1950. Gray's New Manual of Botany. 8th Ed. American Book Co., New York.

Fuller, H. J. 1948. Carbon dioxide concentrations of the atmosphere above Illinois forest and grassland. Amer. Mid. Nat., 39: 247–249.

Gut, R. C. 1929. Le Gas Carbonique dans L'Atmosphere Forestiere. J. For. Suisse, Sup. 3.

———. 1938. L'Occupation de L'Atmosphere. J. For. Suisse., 89: 195–292, 236–243.

———. 1939. Assimilation chlorophyllienne avant le lever du soleil. J. For. Suisse., 90: 251–258.

Harder, R., P. Filzer, and **A. Lorenz.** 1931. Über Versuche zur Bestimmung der Kohlensäureassimilation immergrüner Wüslerpflanzen während der Trockenzeit in Beni Unif (algerische Sahara). Jahrb. Wiss. Bot., 75: 45–194.

Heinicke, A. J., and **M. B. Hoffman.** 1933. The rate of photosynthesis of apple leaves under natural conditions, Part I. Cornell Univ. Agr. Expt. Sta. Bull. 577.

Johnsson, N. 1926. Okologische studien über den Gasaustausch einiger Landpflanzen. Sv. Bot. Tidskrift, 20: 107–236.

Letts, E. A., and **R. F. Blake.** 1900. The carbonic anhydride of the atmosphere. Royal Dublin Society. Sc. Pro. N. S. 9: 107–270.

Lundegardh, H. 1921. Ecological studies in the assimilation of certain forest-plants and shore-plants. Sv. Bot. Tidskrift, 15: 46–95.

———. 1924. Der Kreislauf der Kaulensäure in der Natur. Gustav Fischer, Jena.

———. 1931. Environment and plant development. 2nd Ed. (Trans. and Ed. by Eric Ashby) Arnold, London.

McComb, A. L., and **W. E. Loomis.** 1944. Subclimax prairie. Bull. Torr. Bot. Club, 71: 46–76.

McLean, R. C. 1919. Studies on the ecology of tropical rain forest. Jour. Ecology, 7: 5–56, 121–172.

Meinecke, T. 1927. Die Kohlenstoffernährung des Waldes. Julius Springer, Berlin.

Romell, L. -G. 1922. L'Aeration du sol. Rev. Int. Renseign Agricoles. N. S. 1: 299–315.

———. 1928. Studien über den Kohlensäurehaushalt im moss reichem Kiefernwald. Meddelanden fran Statens Skogsforsoksanstalt, 24: 1–56.
———. 1932. Mull and duff as biotic equilibria. Soil Sci., 34: 161–188.
Russell, E. J., and **A. Appleyard.** 1915. The atmosphere of the soil, its composition and the causes of variation. Jour. Agr. Sci., 7: 1–48.
Schimper, A. F. W., and **F. C. von Faber.** 1935. Pflanzengeographie auf physiologischer Grundlage. 3 Aufl. Gustav Fischer, Jena.
Stauffer, C. R., G. D. Hubbard, and **J. A. Bownocker.** 1911. Geology of the Columbus Quadrangle. Geol. Surv. Ohio. 4th Ser., Bull. 14.
Stocker, O. 1935. Assimilation und Atmung westjavanischer Tropenbaume. Planta, 24: 402–445.
Turpin, H. W. 1920. The carbon dioxide of the soil air. Cornell Univ. Agr. Expt. Sta. Mem. 32: 319–362.
Wildermuth, R. W., W. D. Lee, A. H. Paschall, and **J. G. Steele.** 1938. Soil survey of Licking County, Ohio. U. S. Dept. Agric. Series 1930, No. 48.
Wilson, C. C. 1948. Fog and atmospheric carbon dioxide as related to apparent photosynthetic rate of some broadleaf evergreens. Ecology, 29: 507–508.
Wolfe, J. N., R. T. Wareham, and **H. T. Scofield.** 1949. Microclimates and Macroclimate of Neotoma, a small valley in Central Ohio. Ohio Biological Survey Bull. No. 41.

Geography in the Twentieth Century. *Griffith Taylor* (Ed.). Philosophical Library, New York. 1951. xi+630 pp. $4.75.

This volume, written by a number of authors of whom many have Canadian and English backgrounds, attempts a survey of the status of geography as a physical and social science in the first half of the twentieth century. The book is divided into three parts. The first part consists of a summary of the evolution of geography and its philosophical basis. The second chapter, "Geography in the Nineteenth Century" by George Tatham, is a well-packed summary of the history of the subject in the last century. There follows two brief chapters in which the work of the French, German, and West Slav geographers is described and their contributions evaluated. This section of the book ends with a chapter by Tatham on environmentalism and possibilism.

Part Two concerns itself with "the Environment as a Factor" (minor comment by the reviewer: a factor in what?) The chapters herein cover the present status of research in geomorphology, meteorology, the influence of climatic conditions on human affairs, soils, pioneer settlement, the Arctic and Antarctic regions, and the tropics. This part of the book concludes with a discussion of geography and regionalism by E. W. Gilbert, and a brief description of the British Land Use Survey.

Part Three, "Special Fields of Geography" includes the chapters on the practical aspects of the subject: political, racial, social, and urban geography; aviation; and chapters on geographical societies and employment of geographers in the federal branches in Washington. The final chapter is a glossary of geographical terms, so condensed and abridged that it has relatively little meaning. One might wonder why the so-called geographical terms "cephalic index," "couvade," and "Hittite," should appear in such a compilation.

The reader of the volume will probably find himself stimulated by the aspects of the theory presented, and he will find himself annoyed at times by minor contradictions, many of which have grown out of the fact that the chapters have been written by different individuals. To cite one instance: Tatham states on Page 148, "Doubts about the simple environmental explanation of racial differentiation are raised by the persistence of people in Amazonia for several thousand years without the development of those negroid features that we generally assume to be physiological adjustments to a tropical climate." Visher, on page 216, states, " . . . there is a rough correlation between the amount of sunshine and human skin colour. The blond people are found in regions of inadequate sunshine, and the dark-skinned people in regions of sunshine." Such conflicts in opinion would have been avoided by greater attention to the editing of the volume. Other evidence of inadequate editing appear in minor details; Oscar Schmieder appears as Otto Schmieder; *New Compass of the World* is cited as *Compass of the North.*

On the whole, however, the professional geographer will find this volume helpful as a mid-century summary of his subject. It should prove particularly useful for advanced students who are interested in the development of geography and the lines along which it is progressing.

H. F. Raup

VERTICAL TEMPERATURE GRADIENTS IN A BEECH FOREST IN CENTRAL OHIO[1]

HARLAN R. CHRISTY

Department of Botany and Plant Pathology, The Ohio State University, Columbus 10

Vertical temperature gradients in forests are the result of, and at the same time reflect, a complex of microclimatic layers, formed and controlled in large part, by the vegetation itself. Density of the canopy and luxuriance of the understory as well as the presence or absence of other layer societies are the primary controls of these gradients in the summer season. Geiger (1927) concludes "that the crown surface [canopy] is the main cause of changes in the condition of the air in a forest; the soil surface functions as a surface in the meteorologic sense only under experimental conditions." More precisely, the canopy is the primary control of air conditions in a forest during the verdant season; the substrate functions as a major control only during the leafless season, rarely during the season of closed canopy.

Not only are diurnal temperature regimes at various levels in forests different from each other from season to season, but there are also considerable differences in temperature between various levels during daily regimes of a single season. The literature concerning these phenomena is fragmentary and deals mostly with short-time measurements, some of them for less than a day's duration. Some studies have been made in various levels of forest vegetation, but most notably in the canopy and near the substrate. No all-season, continuous, simultaneous measurements of temperature at different levels in a forest, from beneath the substrate to the canopy layer, are known to the writer.

Fowells (1948) described a temperature profile in a pine forest in California. He found that the highest average maximum (83.6°)[2] and lowest average minimum (31.8°) air temperatures for the month of August occurred at the forest floor. Lowest average maximum (80.4°) and highest average minimum (34.4°) air temperatures for the same period were recorded at a station 120 feet above the forest floor. This is in direct contrast to summer temperature phenomena for a Beech Forest reported in the present paper. Geiger (1950) stated that air temperatures at 2.4 m are considerably higher during the day and lower at night in an open fir stand than in a fir stand with pine undergrowth. The more dense the canopy, the more slowly the air beneath it mixes with the outside air. Wolfe, Wareham, and Scofield (1949) have made weekly min-max temperature studies near the substrate in several types of forest vegetation over a period of five years. Geiger (1950) briefly discussed a few investigations of forest temperatures and reported that Ungeheuer (1934) found that higher temperatures occur in the canopy during the diurnal course of the temperature march than in the trunk space and 3 m above the ground in a 136-year-old beech stand. Geiger and Amann (1931, 1932) found temperatures in an oak forest lowest and most uniform 3 m above the forest floor, highest and most unsettled in the canopy, and decreasing with decreasing heights within the forest during diurnal temperature regimes. Von Lorenz-Libernau (1890) stated that, at night, forest temperature differences are slight between the various levels. Either the whole air mass is isothermal or, if the canopy is sufficiently dense, the cold air remains above it. Geiger (1950) said, with reference to a pine stand, that minimum temperature differences occur between the space above the crown and above the forest floor about noon when the sun penetrates into the forest and conduction is most highly developed.

[1]Department publication 532. Personal acknowledgments are made to John N. Wolfe.

[2]All temperatures are Fahrenheit.

THE PROBLEM AREA

The present study of vertical temperature gradients was conducted in a Central Ohio Beech Forest. Measurements were made in an area near the center of an 11-acre forest tract. On an acre quadrat, in the center of the tract, are 82 trees over 5 inches in diameter. The number of trees in the various size classes are indicated in table 1. DeSelm (1952) has described the soils, topography, and vegetation in greater detail.

TABLE 1

Tree species in the problem area and numbers of individuals over 5 inches in diameter

Diameter (inches)	Species						Totals
	Beech	Sugar Maple	Elm	White Ash	Black Cherry	Red Oak	
5–10	3	2	6	4	3	0	18
11–15	9	4	3	2	0	0	18
16–20	22	4	2	1	0	0	29
21–25	8	1	2	0	0	0	11
26–30	5	0	0	0	0	0	5
31–38	0	0	0	0	0	1	1
Totals	47	11	13	7	3	1	82

METHODS OF TEMPERATURE MEASUREMENT

Temperatures were first recorded April 30, 1950, and measurements were continued through December 31, 1950. During this study, temperatures were obtained at eight stations at different levels in the forest complex, from four feet below the forest floor to 80 feet above it.

A Leeds and Northrup Micromax Recorder (Model S 40000 series) was used for recording all temperatures. The thermocouples were of 16-gauge iron-constantan wire and those above ground were so placed that they were exposed in a vertical straight line 18 inches from the tree on which the lead wires were attached. The lead wires from each station were connected to the Micromax which recorded the temperature of that station once every eight minutes. Thus, a continuous record for the whole period of the investigation was recorded. Thermocouples were located and continuous records obtained from points four feet below leaf litter, six inches below leaf litter, just under leaf litter, just over leaf litter, five feet above leaf litter, 20 feet above leaf litter and 20 feet below the lowest branches of the canopy trees, 62 feet above leaf litter, and 82 feet above leaf litter near the top of the canopy.

FOREST TEMPERATURE REGIMES IN SUMMER

In summer,[3] the over-all range of temperature in the forest is from 46° to 89°. Both minimums and maximums were a few degrees below the extremes (50°–95°) of the macroclimate.[4] This is in agreement with many observations that forested

[3]Seasons have been delimited on the basis of phenological phenomena according to the criteria used by Wolfe, Wareham, and Scofield (1949). The calendar dates used in this paper are: summer, May 23–September 11; fall, September 12–November 3; winter, November 4–December 31 (incomplete); spring, April 30–May 22. No data were obtained in early spring.

[4]The macroclimate is here considered to be represented by Weather Bureau data (Columbus, Ohio, station).

areas are cooler than non-forested areas. In table 2, the summer minimums and maximums in the forest are compared with the macroclimatic extremes.

TABLE 2

Maximum and minimum temperatures for summer (1950) at eight different levels in a Beech Forst compared with those of macroclimate.

	Station								
	−4 ft.	−6 in.	Under leaf litter	Leaf litter surf.	5 ft.	20 ft.	62 ft.	82 ft.	Weather Bureau
Max. Temp.	61°	66°	72°	83°	84°	86°	86°	89°	94°
Date	7/17	7/20	7/17	7/17	8/17	8/17	8/17	8/17	6/26
	9/6	8/18	8/17						8/17
Min. Temp.	51°	54°	54°	49°	48°	48°	48°	46°	50°
Date	5/23	5/23	5/23	6/18	6/18	6/18	6/18	6/18	6/4
Range	10°	12°	18°	34°	36°	38°	38°	43°	44°

Maximum temperatures become progressively higher with ascent from the lowest station four feet below the leaf litter, and minimums become progressively lower from six inches below the litter upwards. Thus the ranges become progressively greater, and in the canopy in summer, approximate the range in temperature of the macroclimate.

Even these extremes show the striking similarity in temperature regimes at various levels of the forest beneath the canopy and above the substrate in summer. Average diurnal differences in the summer profiles are small, as it is indicated in figure 1. Moreover, the actual seasonal temperature conditions, indicated in table 3, show a remarkable similarity and narrow amplitude. For example, temperatures over the substrate are between 60° and 79° 82 percent of the summer season; in the same range at five feet, 81 percent of the time; at 20 feet, 79 percent; and at 62 feet, 78 percent. The striking differences in temperature climates in the forest in summer are between those levels below the substrate and those above it.

TABLE 3

Temperatures at eight stations in a Beech Forest during summer compared in terms of percentage of total time at various degree ranges.

	Station							
	−4 ft.	−6 in.	Under leaf litter	Leaf litter surf.	5 ft.	20 ft.	62 ft.	82 ft.
80°–89°	0	0	0	2	4	5	5	6
70°–79°	0	0	6	32	34	34	31	33
60°–69°	30	88	79	50	47	45	47	47
50°–59°	70	12	15	15	14	15	15	13
40°–49°	0	0	0	1	1	1	2	1

Soil temperatures in summer at a depth of four feet range from 51° to 61°, rising gradually from the lower temperature to the higher at the rate of one degree per week until mid-July. During late July and August there is slight fluctuation from 61° during early morning to 60° during the day.

At a depth of six inches, the summer temperature range is 12 degrees, from 54° to 66°. The maximum is attained in mid-July, the rise from 54° occurring at the rate of about a degree per week. Daily fluctuations, however, are greater than at four feet, but rarely are as much as three degrees. Temperatures are between 61° and 66° 88 percent of the summer season (table 3).

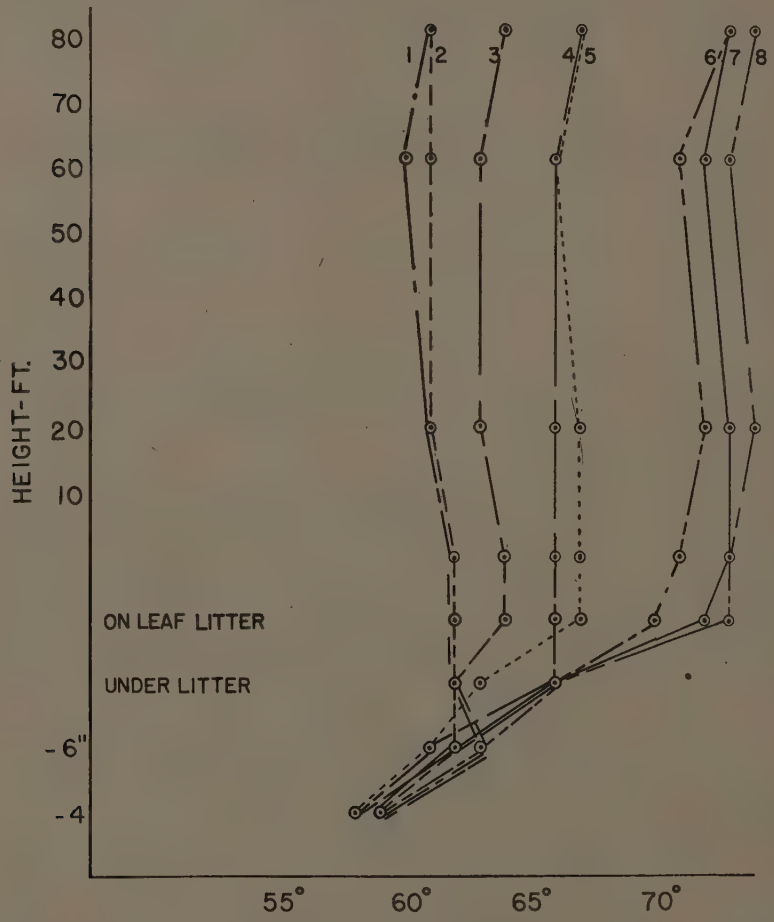


FIGURE 1. Average vertical temperature gradients in a beech forest in summer at different hours of the day. In this and following figures, curve number 1 represents the gradient at 3 A.M., 2 at 6 A.M., 3 at 12 midnight, 4 at 9 P.M., 5 at 9 A.M., 6 at 6 P.M., 7 at 3 P.M., and 8 at 12 noon.

The summer temperature range under leaf litter is 18 degrees, from 54° to 72°, but temperatures are between 60° and 69° 79 percent of the time (table 3). Daily temperatures fluctuate as much as nine degrees, rising one degree for approximately every three degree rise in temperature above the leaf litter, and decreasing at about the same rate.

FOREST TEMPERATURE REGIMES IN FALL

In fall, the over-all range of temperature in the forest was between 34° and 85°. The minimum was a few degrees below and the maximum a few degrees above the extremes (38°–83°) of the macroclimate. With thinning of the canopy as the leaves begin to fall, fluctuations in temperature at various levels become greater than in summer. In table 4, the fall minimums and maximums are compared with the macroclimate extremes.

TABLE 4

Maximum and minimum temperatures for fall (1950) at eight different levels in a Beech Forest compared with those of macroclimate.

	Station								
	−4 ft.	−6 in.	Under leaf litter	Leaf litter surf.	5 ft.	20 ft.	62 ft.	82 ft.	Weather Bureau
Max. Temp.	60°	63°	67°	82°	77°	81°	84°	85°	83°
Date	9/17 9/24	9/22	9/19	10/21	10/18	10/21	10/18	10/17	10/31
Min. Temp.	56°	54°	46°	36°	36°	35°	35°	34°	38°
Date	10/23 10/26	10/26	9/25	10/26	10/26	9/24	9/24	9/24	9/24
Range	4°	9°	21°	46°	41°	46°	49°	51°	45°

Maximum temperatures are progressively higher from four feet below the leaf litter to the leaf litter surface. A decrease from the temperature at the leaf litter surface occurs at five feet, after which temperatures become higher with ascent. Thus, during fall, two maximums occur: one in the canopy and a second weak maximum over the leaf litter (see also fig. 2). Minimum temperatures become progressively lower from four feet beneath the leaf litter upward to the canopy. The range at the surface of the leaf litter closely approximates the range in temperture of the macroclimate and the range at the canopy is greater than the range of the macroclimate during fall.

TABLE 5

Temperatures at eight stations in a Beech Forest during fall compared in terms of percentage of total time at various degree ranges.

	Station							
	−4 ft.	−6 in.	Under leaf litter	Leaf litter surf.	5 ft.	20 ft.	62 ft.	82 ft.
80°–89°	0	0	0	1	0	0	1	2
70°–79°	0	0	0	8	9	12	9	13
60°–69°	12	37	41	40	38	35	36	35
50°–59°	88	63	53	35	37	36	36	35
40°–49°	0	0	6	14	14	14	14	13
30°–39°	0	0		2	2	3	4	2

The pattern of minimum extremes is strikingly similar to the average nocturnal profile (fig. 2) but the diurnal average departs considerably from the pattern of maximum extremes (table 4 and fig. 2). Diurnal differences between above-ground stations in the forest are not great except near the leaf litter, as is indicated in figure 2. However, the actual seasonal temperature conditions, indicated in table 5, are similar. Temperatures over leaf litter and at five feet above it are

between 50° and 69° 75 percent of the fall season; in the same range at 20 feet, 71 percent of the time; at 62 feet, 72 percent of the time; and at 82 feet, 70 percent of the time. The most striking feature of fall temperatures is the wide range at the substrate in comparison to those of summer.

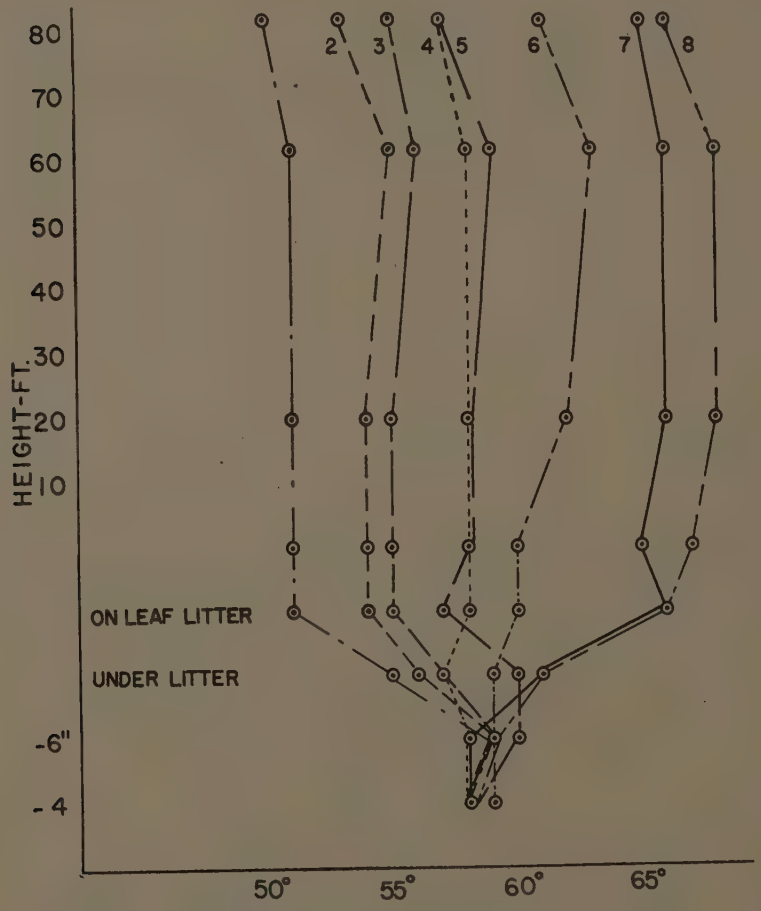


FIGURE 2. Average vertical temperature gradients in a beech forest in fall at different hours of the day.

FOREST TEMPERATURE REGIMES IN WINTER

In winter, the over-all range of temperature in the forest was from −6° to 57°. Both minimum and maximum temperatures were slightly lower than the extremes (−3° to 65°) of the macroclimate. In table 6 winter minimums and maximums are compared with macroclimatic extremes.

Maximum temperatures decrease progressively from a depth of four feet up to the leaf litter surface, increasing from the leaf litter surface to 20 feet, then decreasing at 62 feet and 82 feet. Maximum temperature at four feet beneath the surface is exceeded only by the maximum temperature at 20 feet. Minimum temperatures decrease from four feet beneath the surface to the canopy, but higher minimum air temperatures occur at 20 feet and 62 feet than at five feet and 82 feet. Thus the greatest range occurs at five feet but is lower than the temperature range of the macroclimate.

TABLE 6

Maximum and minimum temperatures for winter (1950) at eight different levels in a Beech Forest compared with those of macroclimate.

	Station								
	−4 ft.	−6 in.	Under leaf litter	Leaf litter surf.	5 ft.	20 ft.	62 ft.	82 ft.	Weather Bureau
Max. Temp.	56°	55°	50°	47°	54°	57°	56°	56°	65°
Date	11/4	11/4	11/4	12/6	12/3	12/2	12/2	12/2	11/7
Min. Temp.	40°	37°	32°	17°	−6°	3°	1°	0°	−3°
Date	12/28 12/31	12/28 12/31	12/28	12/27	12/27	12/27	12/27	12/27	12/27
Range	16°	18°	18°	30°	60°	54°	55°	46°	68°

The patterns of minimum and maximum temperature extremes are strikingly similar to the average daily profiles indicated in figure 3. Daily differences in average temperature during winter do not exceed six degrees. However, because the thermocouple at the leaf litter surface was snow-covered much of the season, the actual seasonal temperature conditions at ground level differ conspicuously from the various other levels (table 7). For example, temperatures beneath the snow[5] range from 20° to 39° 88 percent of the winter season; in the same range at

TABLE 7

Temperatures at eight stations in a Beech Forest during winter compared in terms of percentage of total time at various degree ranges.

	Station							
	−4 ft.	−6 in.	Under leaf litter	Leaf litter surf.	5 ft.	20 ft.	62 ft.	82 ft.
50°–59°	16	9	2	0	2	3	3	3
40°–49°	84	74	46	8	10	9	7	8
30°–39°	0	17	52	59	34	34	24	23
20°–29°	0	0	0	29	34	38	44	41
10°–19°	0	0	0	4	15	13	18	20
0°– 9°	0	0	0	0	4	3	4	5
−10°– −1°	0	0	0	0	1	0	0	0

five feet and 62 feet, 68 percent of the time; at 20 feet, 72 percent of the time; and at 82 feet, 64 percent of the time.

Soil temperatures in winter, at a depth of four feet, range from 56° to 40°, decreasing at the rate of two degrees per week. Lowest temperatures occur

[5]No thermocouple was installed at the snow surface.

around noon and highest temperatures around midnight. Eighty-four percent of winter season temperatures occur between 40° and 49°.

Soil temperatures at a depth of six inches range from 37° to 55°, with temperatures above 50° occurring in the first week of winter only. Daily fluctuations of four degrees are common, with highest daily temperatures occurring around midnight and lowest daily temperatures around noon.

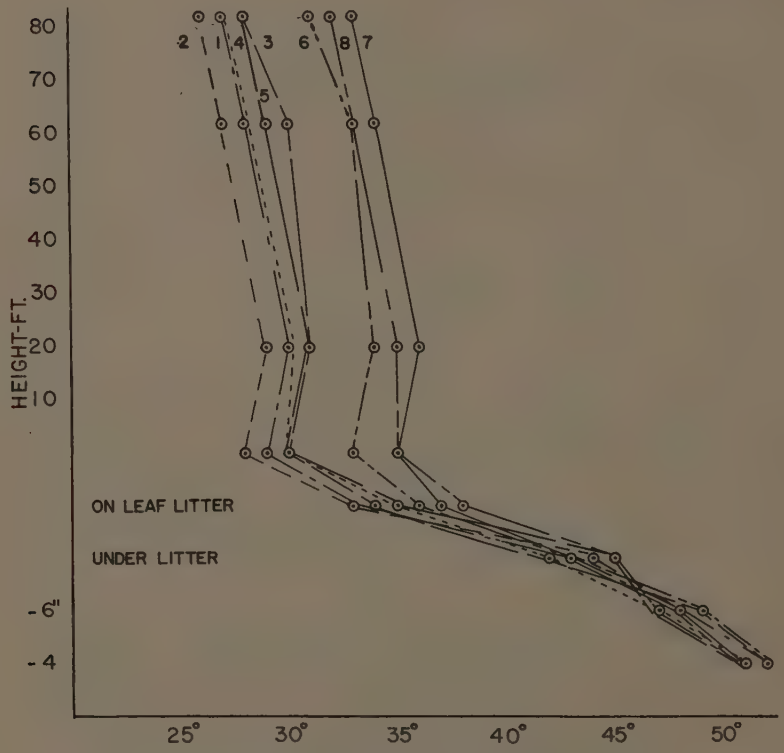


FIGURE 3. Average vertical temperature gradients in a beech forest in winter at different hours of the day.

Temperatures under leaf litter range from 32° to 50°, with temperatures between 32° and 39° occurring 52 percent of the time. Although zero and sub-zero air temperatures occur, temperatures under leaf litter are never lower than 32°. Daily temperature fluctuations exceeding five degrees are very rare at this station during the winter season.

Occurrence of highest air temperatures at 20 feet, lowest air temperatures at five feet, the narrow range of temperatures at the leaf litter surface, and the small range of substrate temperatures are outstanding features of the temperature climate in the forest during winter.

EFFECT OF SNOW COVER

During winter conditions, snow not infrequently is an additional factor in control of temperatures in the upper soil horizons. On November 23, 1950, a cold front accompanied by snow entered the problem area. By noon of November 24, the temperature under the snow was 28° while the temperature five feet above[6] the snow was 14°. During the days following, until air temperatures became higher than 25°, the minimum differences under snow and five feet above exceeded 10 degrees.

On December 7, a cold front without snow entered the area. The temperature at the leaf litter dropped more slowly than the temperature five feet above. When air temperatures were at a minimum, temperature at the leaf litter was three degrees higher than at five feet above. In the following days, temperatures at the leaf litter were seldom greater than, and usually the same as temperatures five feet above the leaf litter.

FOREST TEMPERATURE REGIMES IN SPRING

During the spring season, the over-all temperature range is from 35° to 121°. The over-all maximum is much higher and the minimum is lower than the extreme temperature (41°–87°) of the macroclimate. In table 8, maximum and minimum temperatures[7] are compared with the macroclimatic extremes.

TABLE 8

Maximum and minimum temperatures for spring (1950) at eight different levels in a Beech Forest compared with those of macroclimate.

	Station								
	−4 ft.	−6 in.	Under leaf litter	Leaf litter surf.	5 ft.	20 ft.	62 ft.	82 ft.	Weather Bureau
Max. Temp.	52°	58°	92°	121°	90°	78°	78°	78°	87°
Date	5/21	5/5	5/5	5/5	5/5	5/14	5/14	5/14	5/5
Min. Temp.	45°	47°	40°	37°	35°	45°	44°	45°	41°
Date	4/30	5/2	5/8	5/8	5/8	5/19	5/19	5/19	5/7
Range	7°	11°	52°	84°	55°	33°	34°	33°	46°

Maximum temperatures increase from four feet beneath the surface to the leaf litter and then decrease at five feet. Minimum temperatures are highest six inches below the surface and lowest five feet above. The maximum temperature of 121° at the leaf litter surface is probably high due to exposure at the thermocouple, but the maximum temperature of 92° under the leaf litter indicates that it is probably not a great departure from the real temperature.

The pattern of maximum temperature extremes is similar to the average profile at 12 noon in spring (fig. 4), while the other average profiles are in contrast to the pattern of either the maximum or minimum extremes (fig. 4 and table 8). Daily fluctuations in temperature are great during spring. Moreover, the actual seasonal temperature conditions differ conspicuously at the various levels (table 9). For example, temperatures at the leaf litter surface are above 80° over 7 percent of the time but do not reach 80° at any other level. The wide distribution of temperature

[6]Nearest thermocouple to the snow surface.

[7]Maximum and minimum temperature data at 20 feet, 62 feet, and 82 feet were not obtained for the first 15 days of the investigation, and these stations are therefore omitted from the comparisons.

at the leaf litter surface is the most outstanding feature of forest temperature in spring, and emphasizes the importance of the forest floor as a meteorological control at this important season.

TABLE 9

Temperatures at eight stations in the Beech Forest during spring compared in terms of percentage of total time at various degree ranges.

	Station							
	−4 ft.	−6 in.	Under leaf litter	Leaf litter surf.	5 ft.	20 ft.	62 ft.	82 ft.
110°–121°	0	0	0	+	0	0	0	0
100°–109°	0	0	0	1	0	0	0	0
90°– 99°	0	0	+	2	+	0	0	0
80°– 89°	0	0	+	4	3	0	0	0
70°– 79°	0	0	2	10	13	11	11	15
60°– 69°	0	0	17	30	30	40	38	33
50°– 59°	47	90	70	41	42	42	42	44
40°– 49°	53	10	10	11	11	7	9	8
30°– 39°	0	0	0	+	+	0	0	0

Soil temperatures at a depth of four feet range from 45° to 52°, rising at the rate of two degrees per week through the season. Daily maximum temperatures occur from late afternoon to midnight and lowest daily temperatures occur from midnight to noon. Soil temperatures at a depth of six inches range from 47° to 58°, rising at the rate of three degrees per week as the season progresses. Highest daily temperatures occur in the evening and lowest daily temperatures occur around noon.

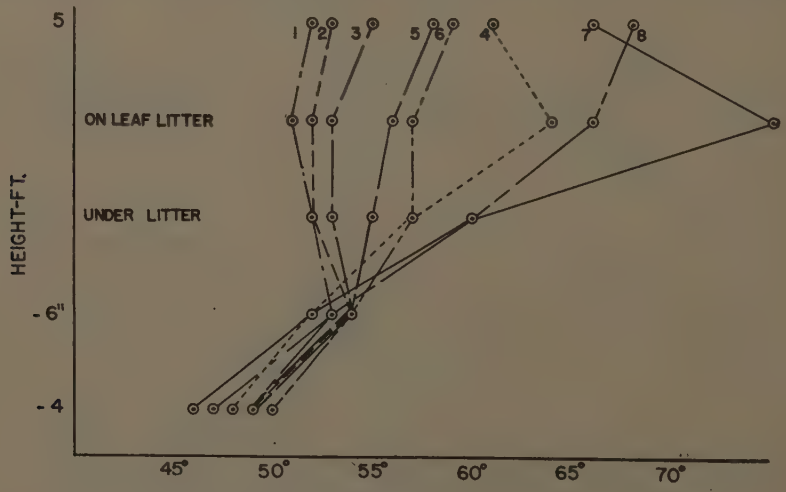


FIGURE 4. Average vertical temperature gradients in a beech forest in spring at different hours of the day.

Temperatures just under the leaf litter fluctuate more and have a wider range, 40°–92°, during spring than at any other season. Daily fluctuations may be as great as 33 degrees and fluctuations of 15 degrees are very common. Temperatures occur in a range of 50° to 69° 71 percent of the time.

SUMMARY

Temperatures were measured at eight different levels in a Central Ohio Beech Forest continuously from April 30 through December 31, 1950, by means of thermocouples attached to a Leeds and Northrup Micromax Recorder. Thermocouples were located four feet below the leaf litter, six inches below the leaf litter, just under the leaf litter, just above the leaf litter, five feet above leaf litter, 20 feet above leaf litter and 20 feet below the lowest branch, 62 feet above leaf litter, and 82 feet above leaf litter, near the crown surface.

Data were compiled to show vertical temperature gradients and temperature regimes at various levels during different seasons of the year.

1. In summer, the greatest extremes of temperature (46° to 89°) occur in the canopy and temperature regimes at other levels above and below the forest floor are more stable than at any other season. At this season, the temperature regimes beneath the canopy and above the substrate are nearly uniform (no stratification) because of canopy control of the weather beneath it. Soil temperatures are higher near the surface (54° to 66°) than at a depth of four feet (51° to 61°).

2. In fall, greatest extremes of temperature (34° to 85°) also occur in the canopy, but there is some stratification due to thinning of the canopy by leaf fall and penetration of more sunlight to the forest floor than in summer. Minimum soil temperatures are higher in the lower soil regions than near the surface.

3. Winter minimum temperatures are lowest near the substrate (−6°) but temperature regimes at all levels are more uniform than in the summer as a result of greater turbulence in the absence of the canopy. In the soil, minimum and maximum temperatures are slightly lower near the surface than at a depth of four feet. Beneath the leaf litter, temperatures do not go below freezing, with or without snow cover. In the upper soil, temperatures are between 40° and 49° 74 percent of the winter period, but air temperatures occur in that range from seven to ten percent of the time and are lower than that from 88 to 90 percent of the time.

4. Minimum and maximum air temperatures in spring occur at the lower levels, the leaf litter surface sometimes measuring over 100°. The forest floor is the effective meteorological surface at this season, and the widest range of temperatures of the year occur there. Stratification above this layer is not pronounced because turbulence is still great in the absence of the canopy. Soil temperatures are high near the surface (up to 92°) and diffusion of heat downward is more rapid than at any other season.

REFERENCES CITED

DeSelm, H. R. 1952. Carbon dioxide gradients in a beech forest in central Ohio. Ohio Jour. Sci., 52: 187–198.

Fowells, H. A. 1948. Temperature profile in a forest. Jour. Forestry, 46: 897–899.

Geiger, R. 1927. Das klima der bodennahen luftschicht. Die Wissenschaft, Vol. 78. Braunschweig, Vieweg. (Translation by John Leighley.)

Geiger, R. 1950. The climate near the ground. Harvard Univ. Press. Cambridge, Massachusetts.

Geiger, R., and **H. Amann.** 1931, 1932. Forstmet. mess. in e. eichenbestand (5 teile). Forstwissenschaftliches Centralblatt, 53: 237–250, 341–351, 705–714, 809–819; 54: 371–383.

Lorenz-Libernau, von. 1890. Resulte forstlich-meteorologischer. Mitt. aus d. forstlich. Versuchswesen Osterreichs, XII and XIII, Wien.

Ungeheuer, H. 1934. Microklima in e. buchenwald am Hang. Bioklimatische Beiglatter der Meteorologischen Zeitschrift, 1: 75–88.

Wolfe, J. N., R. T. Wareham, and **H. T. Scofield.** 1949. Microclimates and macroclimate of Neotoma, a small valley in central Ohio. Ohio Biol. Surv. Bull. 41.

The Ohio Journal of Science award for excellence in research for 1952 was made to Dr. E. R. Caley at the Annual Banquet and Business Meeting of The Ohio Academy of Science at Kent State University on April 18, 1952. Dr. Caley's paper "Chemical Examination of an Ancient Sheet of Metal of Unique Composition Found in Greece," appeared in the May number of the Journal.

SOME PARASITES OF FISHES OF THE UPPER GATINEAU RIVER VALLEY

DAVID E. WORLEY AND RALPH V. BANGHAM
Cadiz, Ohio, and The College of Wooster, Wooster, Ohio

This report summarizes a study of some of the parasites of fish of the upper Gatineau drainage system in southwestern Quebec, Canada. Collections were made in eight lakes and streams in Gatineau and Pontiac counties during the

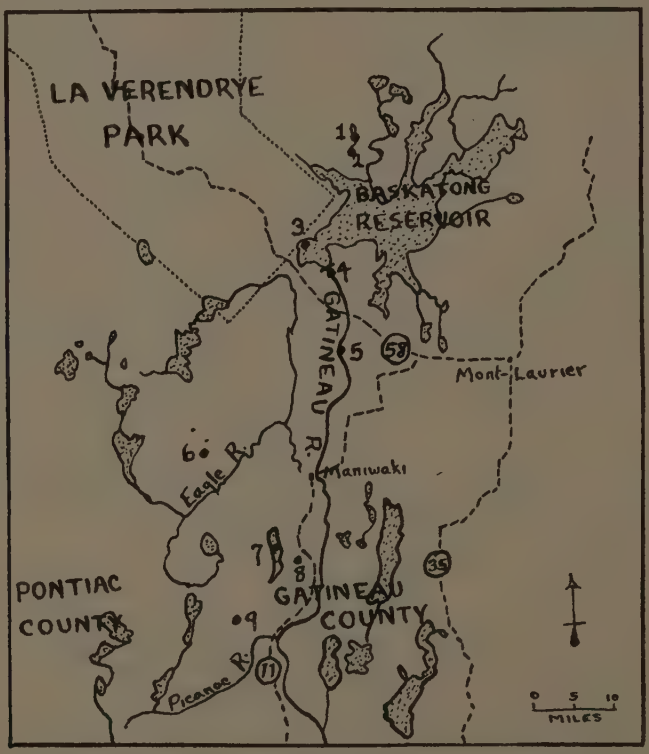


FIGURE 1. The upper Gatineau valley. Collecting points indicated by •. 1. Ruis Côte Jaune. 2. Lac Petite Jaune. 3. Western arm of Baskatong Reservoir. 4. Gatineau River below Mercier Dam. 5. Gatineau River at Chute de Grand Remous. 6. Flynn Lakes. 7. Blue Sea Lake. 8. Grant Lake. 9. Lake McGoey.

months of June, July, and August, 1950. The following procedure was used in examining the fish. First, the exterior of the specimens, including the skin, gills, and fins, was searched. Second, the viscera were removed and examined. Parasites were first placed in a physiological saline solution to inhibit the formation of a

mucus layer about them, and then were transferred to ten percent formalin for killing and then to a five percent formalin solution for preserving. Although these killing and fixing methods are not recommended where better facilities are available, they proved to be adequate under the existing conditions, i.e., collection and preservation of material in the field. Most of the parasites were examined with a binocular microscope at the time of dissection, but no final identifications were attempted until the specimens were brought back to the laboratory, where slides of the stained material were prepared. All of the parasites were stained with Delafield's hematoxylin and mounted in Canada balsam except the nematodes, which were cleared and mounted unstained.

TABLE 1

Collecting data

Species of Fish	Place Collected	No. Examined	Percent Parasitized	Parasites
Speckled Trout	Flynn Lakes	9	100	*Eubothrium salvelini*
Black Bullhead	Blue Sea Lake	2	100	*Allocreadium ictaluri* *Corallobothrium fimbriatum*
Yellow Perch	Blue Sea Lake	10	40	*Clinostomum margination* *Dichelyne cotylophora* *Contracecum* sp. *Illinobdella* sp. *Actinobdella* sp.
Walleye	Baskatong Reservoir	28	100	*Bothriocephalus cuspidatus* *Proteocephalus stizostethi* *Proteocephalus* sp. *Contracecum* sp.
Northen Pike	Lac Petite Jaune Ruis Côte Jaune Baskatong Reservoir Gatineau River	37	37.8	*Proteocephalus pinguis* *Proteocephalus stizostethi* *Contracecum brachyurum* *Leptorhyncoides thecatus*
Chain Pickerel	Grant Lake	1	100	*Proteocephalus pinguis*
Smallmouth Black Bass	Lake McGoey	2	100	*Leptorhyncoides thecatus*

Of a total of 89 fish examined, 60 or 67.4 percent were found to harbor parasites of some kind. In comparison with other surveys in this same general area, this incidence of infection seems rather low. Bangham (1941) found that 84.3 percent of the fish from Algonquin Park lakes were parasitized, and a later study of his in the same locality (Bangham and Venard, 1946) showed that 75.8 percent carried parasites. On the other hand, this amount of deviation seems likely enough when degree of infection in the individual species of fish is considered. Choquette (1948) found 28.6 percent of the speckled trout from Laurentide Park in eastern Quebec infected with *Eubothrium salvelini*. MacLulich (1943) in a study of the parasites of the speckled trout in Algonquin Park found 66 percent were parasitized. In the upper Gatineau valley, all of the trout which we examined contained this parasite. Our figures may be of some significance in that they indicate also that the life cycles of certain parasites, especially those of the northern pike, have not yet become established in this region. The strong influence of habitat in determining the distribution of parasites is evident here. All of the pike collected in

the Baskatong Reservoir and a small lake and stream draining into it contained light infections of *Proteocephalus stizostethi*, *P. pinguis*, and *Contracecum brachyurum*, while specimens from the Gatineau river proper were infected only with the spiny-headed worm *Leptorhyncoides thecatus*.

ACKNOWLEDGMENTS

The authors wish to express their gratitude to Mr. Fred H. Glenny and to Dr. Ira N. Gabrielson, who provided much of the material on which this paper is based.

LITERATURE CITED

Bangham, R. V. 1941. Parasites of fish of Algonquin Park lakes. Trans. Amer. Fish. Soc., 70: 161–171

Bangham, R. V., and **C. E. Venard.** 1946. Parasites of fish of Algonquin Park lakes. Pub. Ontar. Fish. Res. Lab., 65: 34–41.

Choquette, L. P. E. 1948. Parasites of freshwater fish. IV. Internal helminths parasitic in speckled trout (*Salvelinus fontinalis* (Mitchill)) in rivers and lakes of the Laurentide Park, Quebec, Canada. Can. Jour. Research, sec. D, 26: 204–210.

MacLulich, D. A. 1943. Parasites of trout in Algonquin Provincial Park, Ontario. Can. Jour. Research, sec. D, 21: 405–412.

Fundamentals of Radio Communications. *Abraham Sheingold.* D. Van Nostrand Company, Inc., New York. 1951. x+442 pp. $5.25.

Quite a few more textbooks and new editions of older publications have been added to the field of electronics and communications in the past five years. The interested group of readers provides the main influence on the selection of materials and manner of presentation by the author. In Professor Sheingold's own words, this book presents "in sufficiently comprehensive form for basic understanding, the principles and techniques in modern radio-communication systems."

There are twenty-one chapter headings in the entire book. After an introduction of transmission principles in general, there follows a discussion of basic radio circuits, generation and propagation of radio waves, and the construction and characteristics of electron tubes. Then separate chapters deal with amplification, rectification, oscillation, modulation, and detection. The last five chapters include pulse circuits, ultra-high-frequency techniques, image-transmission systems, special communication techniques, and radar and radio navigation systems. Each chapter varies in length from fifteen to thirty pages, which seems to be suitable for undergraduate instructional purposes. Diagrams are carefully drawn and faithfully reproduced in readable sizes.

One of the difficulties of teaching an introductory course in engineering subjects seems to be a good balance of basic ideas and methods of analysis on one hand, and a clear, modern, and stimulating overall picture on the other. Here the author has picked up essential topics in radio communication systems and succeeded in treating them neatly and concisely. It should prove a readable book even to students who do not have extensive background in mathematics and electricity.

Both the author and the publishers are to be congratulated in producing this lucid and pleasing introductory textbook with a strong emphasis on modern radio communications. It will prove interesting to follow the new Van Nostrand Series of Communication Engineering, of which this is the first one published.

TSUTE YANG

A STATISTICAL ANALYSIS OF TWENTY POLLEN SPECTRA FROM A SINGLE STRATUM OF AMANDA BOG (OHIO)[1]

THEODORE W. SUDIA

Department of Botany and Plant Pathology, The Ohio State University, Columbus 10

The methodology of pollen analysis is well established. Cain (1944) has enumerated the bases on which the study rests. Erdtman (1943) and others have outlined techniques and have described pollen spectra in connection with bog studies. Erdtman has probably been foremost in outlining the techniques for bog sampling, peat preparation, and statistical analysis. Numerous studies have been made on pollen dissemination, and pollen flotation has been investigated (Cain, 1944; Hopkins, 1951). Attempts have also been made to correlate pollen dissemination with the forest composition of the pollen source (Carroll, 1943).

Bog samplers are used to obtain the samples, which are collected at various depths in the bog. The sampling increment may be one foot or as indicated by Smith (1940) the increment may have to be shorter. The peat is then prepared for microscopic examination. The pollen grains from each sample are identified and counted. The result is computed as a percentage composition for each pollen type. When each pollen spectrum is ascertained, a profile is prepared which shows the change in composition of the spectra with change in depth. From these data it is possible, to some degree, to infer the past forest composition and, therefore, the past climate.

The present study was undertaken to ascertain the statistical relationships between a number of samples from a single stratum.

METHOD

The peat samples were obtained from Amanda Bog, a relict of Wisconsin age, located one half mile north of Amanda, Ohio. This bog was described by Dachnowski (1912). The stratum from which the samples were collected is the transition between the fibrous and limnic peat. This transition, unmistakable in appearance, lies from nine to twelve feet beneath the present surface. It is strongly defined and its variation in depth can be attributed to the gentle slope of the bog surface. This is a result of the movement of soils from the surrounding hills on to the bog.

Twenty samples were taken, thirty feet apart, in a transect across the bog. A Davis Peat Sampler was used. Samples of uniform size were then treated according to the method of Krauss and Kent (1944), and slides for microscopic examination were prepared. One hundred pollen grains from each sample were counted and identified. To identify the pollen, use was made of pollen reference mounts, as well as drawings (Sears, 1930), and photographs (Brown, 1949). The individual spectra were then compared and analyzed statistically.

Statistical methods were used as the only reliable way of ascertaining whether or not differences found were significant.

Table 1 gives the pollen counts for the different species of pollen in the various samples. If these samples were all drawn from the same population, then the relative number of pollen of each species in a sample would vary only by chance from the true proportion. Therefore, it is assumed that the true proportion would

[1]Department Publication 534. Personal acknowledgments are made to Dr. D. Ransom Whitney, Director, Statistics Laboratory, The Ohio State University, and to Dr. John N. Wolfe, under whose direction the work was undertaken.

TABLE 1

Observed and Expected Frequencies of Species in Samples.

Species	*Sample Numbers*																				Total	Mean	S. D.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Abies	24	16	15	13	22	20	24	26	14	20	25	12	25	30	14	31	17	38	24	19	430	21.5	6.63
Quercus	13	23	10	20	21	17	16	16	31	16	15	14	22	13	29	16	11	7	27	14	351	17.5	6.18
Pinus	13	8	24	20	17	28	16	12	9	10	17	24	14	7	6	10	35	17	10	16	313	15.6	7.38
Ulmus	10	11	19	14	5	11	2	8	18	13	5	14	10	9	8	7	6	4	2	7	183	9.1	4.64
Picea	5	3	13	7	5	5	12	12	6	8	8	18	12	16	6	6	15	4	6	7	174	8.7	4.19
Tsuga	10	7	6	9	15	8	6	10	6	10	16	10	8	6	6	2	9	6	8	10	168	8.4	3.12
Unknown	6	6	4	0	2	1	6	5	0	7	8	5	0	7	9	12	2	9	10	10	109	5.4	2.55
Tilia	4	2	1	4	2	3	2	5	7	2	0	1	1	2	6	4	2	2	1	6	57		1.79
Betula	10	7	5	3	1	3	2	0	2	11	2	1	2	6	4	4	1	4	5	6	79		2.82
Juglans	0	0	0	3	1	1	3	0	0	0	0	0	2	0	0	0	0	0	0	0	10		.45
Carya	2	5	0	3	5	3	7	6	3	3	4	1	4	4	5	4	2	7	3	3	74		1.55
Ambrosia	1	8	0	0	1	0	0	0	3	0	0	0	0	0	5	4	0	2	2	2	28		1.58
Compositae	2	1	2	3	3	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	14		.45
Typha	0	3	1	1	0	0	2	0	0	0	0	0	0	0	2	0	0	0	1	0	10		.44
	19*	26	9	17	13	10	18	11	16	16	6	3	9	12	22	16	5	15	12	17	272	13.6	

*This row is the total of the preceding seven species, which were treated together for the purpose of statistical analysis.

be the mean of the totals of all the samples drawn. Thus, the mean is used as the expected frequency in computing whether the observed deviations from this number were greater than would be expected by chance alone.

The test used to ascertain the significance of the differences was the Chi-square test. (In all cases where the total for a species was less than one hundred, the totals were grouped in order to compute Chi-square.)

In order to reject the hypothesis (that these samples are all drawn from the same population) at the one per cent level of significance, Chi-square should exceed 173.00. The Chi-square computed was 358.46, and hence it is concluded that the samples are not from the same population.

CONCLUSIONS

The limitations of this study should be fully understood before any inferences are drawn from it.

Conclusions based on the statistics of this study must be limited to the samples. They cannot be extrapolated to include the bog as a whole. The statistical analysis suggests that the samples come from different populations. It can in no way be extended to the final conclusion that the stratum as a whole contains a heterogenous population.

It can be seen from an examination of the table that the order of magnitude in a large majority of the samples is the same. That is, in almost every case, those counts which are high, are high throughout the table; and those which are low, are low throughout the table.

The many factors which may have contributed to the differences of these samples are not accounted for here. In that respect, these results can not be considered conclusive.

It is, therefore, the opinion of the author that similar studies should be initiated which would embrace more variables and thereby give results which more closely approximate the true situation.

REFERENCES

Brown, G. T. 1949. Pollen-slide Studies. Charles C. Thomas, Springfield, Illinois.
Cain, S. A. 1944. Foundations of Plant Geography. Harper and Bros., New York.
Carroll, G. 1943. The use of bryophytic polsters and mats in the study of recent pollen deposition. Amer. Jour. Botany, 30: 361–366.
Dachnowski, A. 1912. Peat deposits of Ohio. Geol. Sur. Ohio. Bull. 16.
Erdtman, G. 1943. An introduction to pollen analysis. Chronica Botanica, Waltham, Mass. 239 pp.
Hopkins, J. S. 1951. Differential flotation and deposition of coniferous and deciduous tree pollen. Ecology, 31: 633–641.
Krauss, R. S., and **G. N. Kent.** 1944. Analyses and correlation of four New Hampshire bogs. Ohio Jour. Sci., 44: 11–17.
Sears, P. B. 1930. Common fossil pollen of the Erie Basin. Bot. Gazette, 89: 95–106.
Smith, P. 1940. Correlations of pollen profiles from glaciated eastern North America. Amer. Jour. Sci., 238: 597–601.

BACK NUMBERS

Almost all back numbers and volumes of the OHIO NATURALIST and the OHIO JOURNAL OF SCIENCE are available. They may be purchased from the Business Manager at $4.00 per volume or $1.00 per number (postage extra outside U. S. A.).

THE OHIO JOURNAL OF SCIENCE AWARD FOR EXCELLENCE IN RESEARCH

The Ohio Journal of Science will offer awards to persons presenting outstanding original research papers in fields of science represented by sections of The Ohio Academy of Science. For the current year the field of zoology has been chosen by the Joint Administrative Board of The Ohio Journal of Science.

Award

The award for 1953 is $150.00 for the outstanding paper selected in the field of zoology.

Eligibility

1. All participants must be members of the Zoology Section of The Ohio Academy of Science.
2. The manuscript must be either (a) unpublished or (b) published in the Ohio Journal of Science after July 1, 1952.
3. The manuscript must be based upon original research conducted by the participant or participants.
4. The following are not eligible participants: members of the editorial or management staff of The Ohio Journal of Science, members of the Joint Administrative Board, members of the Committee of Judges.

Rules

1. Two copies of each manuscript complete with figures or photographs of figures or two reprints of papers already published in The Ohio Journal of Science must be submitted to the Editor on or before January 1, 1953.
2. If unpublished, the manuscript must be in a form suitable for publication.
3. The right to publish any or all of the unpublished manuscripts submitted, whether prize-winning or not, shall remain with The Ohio Journal of Science until one month after the 1953 meeting of The Ohio Academy of Science. On or before this date, the Editor of The Ohio Journal of Science will return to the authors those manuscripts which he does not choose to publish in The Ohio Journal of Science. Authors of these papers will then be free to publish the results of their research anywhere they choose. At the same time the Editor of The Ohio Journal of Science will inform the authors of those papers which the Editor wishes to publish in The Ohio Journal of Science of this fact, and will set an approximate publication date which will not be later than May 1, 1954.
4. A summary of the paper is to be presented by the author at the 1953 meeting of The Ohio Academy of Science unless the paper has already been published in The Ohio Journal of Science, or unless the program committee of the Zoology Section finds it not feasible to do so.

Selection of Award Winners

1. The Vice President of the Zoology section of The Ohio Academy of Science will choose a Committee of Judges composed of three or more members qualified to judge the manuscripts submitted. The Vice President will designate one of the judges to serve as chairman.
2. The Editor of The Ohio Journal of Science will transmit the manuscripts and reprints submitted to the Committee of Judges.
3. The Committee will select the award winner. The Committee has the obligation to refuse to make an award if, in its opinion, none of the manuscripts is sufficiently high in caliber to be so honored.
4. The winner of the award will be announced at the Annual Banquet and Business Meeting of the Academy in 1953.

IS THE HOUSEFLY BEING REPLACED BY OTHER DIPTERA AS THE MAJOR INSECT PEST OF FOOD MARKETS?

DWIGHT M. DeLONG AND G. MALLORY BOUSH

Department of Zoology and Entomology, The Ohio State University, Columbus 10

There is a general belief that the common house fly, *Musca domestica* L. is the most important insect pest occurring in food, fruit, and meat markets and similar situations where foods are handled in quantity.

For the past three years observations have been made in food markets in many towns and cities in Ohio, New York, Pennsylvania, West Virginia, and Illinois which have indicated that other species of flies are the dominant types and that the house fly is, in most cases, a lesser problem because of its numbers, habits, and appearance.

TABLE 1

Distribution of three species of flies in sample areas in Ohio.

Location	Date	*Phaenicia sericata*	*Phormia regina*	*Musca domestica*	Total Number
			(percent)		
Kenton	7–21	54.1	22.1	23.8	122
Springfield	7–21	64.3	0	35.7	115
Columbus	7–23	50.0	3.8	46.2	52
Springfield	7–25	51.6	3.1	45.3	128
Youngstown	8–3	93.4	0.8	5.8	258
Columbus	8–16	54.5	1.7	43.8	121
Ravenna	8–21	88.6	8.7	2.7	184
Logan	8–23	70.0	12.0	18.0	50
Xenia	8–30	51.1	10.2	38.7	532
Logan	9–5	86.8	6.8	6.4	220
Akron	9–5	87.1	2.0	10.9	101
Geneva	9–6	76.5	0.8	22.7	238
Wooster	9–13	48.7	3.7	47.6	433
Wadsworth	9–13	76.2	0.3	23.5	264
New Lexington	9–18	42.5	1.1	56.4	94
Zanesville	9–19	67.9	0.9	31.1	106
Average percentage		66.1	5.0	28.9	
Total number					3018

During the summer of 1951 quantitative samples were secured from sixteen towns and cities widely distributed over Ohio. The samples were taken by gathering together all of the recently killed insects, following insecticidal treatment, which had accumulated on the broad, show window ledge inside the building. This method of obtaining the samples was used because it was observed that during, and immediately after fog applications of an insecticide, all the flies flew to the large windows in the front of the stores attempting to escape, and died there. Few dead flies could be found in other locations in the buildings. The data cited below are indicative of the general situation in the area studied (table 1).

Sixteen samples in all were counted containing 3018 flies belonging to three species. Of these 1994 or 66.1 percent were *Phaenicia sericata* (Meigen), the green-bottle fly belonging to the family Caliphoridae; 873 or 28.9 percent were

Musca domestica L., the common house fly belonging to the family Muscidae; and 151 or 5.0 percent were *Phormia regina* (Meigen), the black blowfly belonging also to the family Caliphoridae.

Only samples containing 50 or more specimens are included in the data. In table 1, it will be noted that only one sample which was taken at New Lexington, Ohio, on September 18 contained houseflies in excess of 50 percent; only four others of the 16 listed approached 50 percent. The remaining 12 samples contain less than 39 percent of houseflies and four of these contains less than 12 percent.

On the other hand 14 of the 16 samples show that *Phaenicia sericata* is the predominant species with 50 percent or more individuals of this fly in each sample. One sample contained more than 93 percent of this species and 8 samples contained more than 70 percent of *P. sericata.*

The third species of importance is *Phormia regina* which is represented by comparatively smaller numbers. In one case a sample taken at Kenton, Ohio, on July 21 showed 22 percent of the total number to be *P. regina.* In two other samples, Logan, Ohio, August 23 and Xenia, Ohio, August 30, *P. regina* was represented by 10 percent or more of the total number of individuals.

Not only because of their numbers but because both *Phaenicia sericata* and *Phormia regina* are larger, and more strikingly colored than the house fly, and because of their strong attraction to meat where they may be seen to deposit their eggs, they are a much greater and more offensive pest and public health menace than the common housefly.

It would appear that the relative abundance of these three species should be taken into consideration in the research and formulation of fly control methods for restaurants and food markets in the future instead of considering the house fly alone.

Theoretical Foundations of Psychology. *Harry Helson*, ed. D. Van Nostrand Company, Inc., New York. First edition, 1951. xix+787 pp. $7.25.

The editor's purpose is to "treat the fundamental ideas, concepts, theories, and problems which are at the center of the chief divisions of the subject." He states that a number of fields had to be omitted entirely, and that not all the important concepts have been included within each field. Unfortunately, this is true.

However, there are several good chapters: e.g., those on nervous function, neurological correlation of behavior, motivation, feeling and emotion, learning, thinking, and the introductory chapter on methodology. Some chapters, such as those on development, maturation, and fatigue and efficiency have little or no theory in them. In a book of "theoretical foundations" the material of these chapters could perhaps have been included under appropriate heading in other chapters.

An occasional defensive and polemic tone makes the book unsuited for use with any but well-advanced students. Many experiments are discussed too briefly, and in some cases controversial matters are presented from one side only. The chapters are uneven in style and repetition from one chapter to another suggests that combination of the chapters would be in order. There are some errors in printing.

Even so, the virtues of the book should make it useful for advanced and graduate students, with suitable supplementation. It should deepen and broaden the view of present day psychology, as the editor hopes, both by way of acceptance and by way of disagreement. Some stimulating discussions should occur by virtue of the differing theoretical positions represented by the several authors.

CECIL M. FREEBURNE

ANISOTARSUS MACULICORNIS (CHD.) A VALID NAME IN NORTH AMERICAN COLEOPTERA, CARABIDAE[1]

WM. C. STEHR

Department of Zoology, Ohio University, Athens, Ohio

The species under consideration was originally described by Chaudoir (1843) as *Harpalus maculicornis* from a pair of specimens sent him by Chevrolat from Louisiana. Leconte (1853) described a form from Louisiana as *Eurytrichus maculicornis* which he considered to be the same as Chaudoir's species. His description differs in very minor details. Casey (1914) did not recognize the species in his collections but considered it closely allied to *Anisotarsus brevicollis* Chd. and gave a translation of Leconte's Latin description. Leng (1920) listed *A. maculicornis* (Chd.) as a synonym of *A. brevicollis* Chd., however with a question mark. In this listing he evidently drew his conclusions from Casey's remarks on the species.

A. brevicollis was described from Mexico by Chaudoir in 1837. It is the largest species that is keyed in our lists and is easily separated from all of our other species by its size. *A. maculicornis* is about 2 mm longer than any specimen of *A. brevicollis* examined and so would check to that species in our keys. However it is distinct from *A. brevicollis* in many respects in addition to size. The following points selected from the descriptions are sufficient to show this.

A. maculicornis	*A. brevicollis*
1. black, shining	1. black, not shining
2. elytral intervals flat, smooth	2. elytral intervals alutaceous, somewhat opaque
3. scutellar stria short	3. scutellar stria rather long
4. elytra with apex subsinuately truncate	4. elytra with sinus evident near the apex
5. legs brownish	5. legs blackish brown
6. palps rufous	6. palps dark piceous with tips of end segments ferrugineous
7. antennae rufous, segments 2–6 nigrescent	7. antennae testaceous, 3 basal segments partially blackish
8. size: 14.5 mm	8. size: 11–12.7 mm
9. habitat: Mississippi delta region	9. habitat: semi-arid plains of southwest

Anisotarsus maculicornis (Chd.) should be included in our checklist of the Coleoptera North of Mexico as a valid species.

Specimens examined on which the above conclusion is based:

A. maculicornis (Chd.). 3 specimens.
New Orleans, La.: at light, 1 ♀, 11/V/44. J. H. Hughes, Collector.
Morgan City, La.: 1 ♂, 17/IV/38, collector unknown.
Morgan City, La.: 1 ♂, 3/VIII/38, on levee, Wm. C. Stehr, Collector.
(All in collection of the author)

A brevicollis Chd. 76 specimens.
Texas: Dallas Co.; Del Rio; Sanderson, El Paso.
Arizona: Tucson; Patagonia; Hereford.
Mexico: Tamaulipas; Durango.
(In collections of Ohio State University; Illinois Natural History Survey; R. H. Crandall; the author.)

[1]Departmental paper 49.

REFERENCES

Casey, T. L. 1914. Memoirs of the Coleoptera V: 209 and 215–16. Lancaster, Pa.

Chaudoir, M. de. 1837. Genres nouveaux et especes nouvelles de Coleopteres de la famille des Carabiques. Bull. Soc. Imp. Nat. Mos. X: (3) Article VII. Also separate, Kiev, June, 1837, pp. 1–50.

———. 1843. Carabiques nouveaux descrits par le Baron M. de Chaudoir. Bull. Soc. Imp. Nat. Mos. XVI: 671–791.

Leconte, J. L. 1853. Notes on the classification of the Carabidae of the United States. Trans. Amer. Phil. Soc. X: 363–403.

Leng, C. W. 1920. Catalogue of the Coleoptera of America, North of Mexico. Mt. Vernon, N. Y.

General Chemistry. *P. W. Selwood.* Henry Holt and Company, New York. 1950. 681 pp. $4.60.

This book, written by a distinguished physical chemist at Northwestern University, was developed, according to the preface, for the so-called terminal course and is addressed to "that majority of students who are not potential chemists, or who are undecided about a career."

The author has made an excellent selection of topics to be covered. The atomistic rather than the historical approach has been followed, so that the first six chapters are concerned with atomic structure and compound formation, stoichimetry, the states of matter, and the kinetic molecular theory. Then follows the first chapters on descriptive chemistry, with discussions of oxygen, hydrogen, and water, followed by further chapters on the periodic law, kinetics and equilibrium, solutions and ionization. The material becomes descriptive again with eleven chapters on the chemistry of non-metals and metals, including a chapter on electro-chemistry. These are followed by two chapters on nuclear chemistry and atomic power, a chapter on the inorganic chemistry of carbon, and seven chapters on organic chemistry, making a total of thirty-three chapters. To some, the book may seem overlong for the group for which it is intended, but the narrative style, and the inclusion of much material of general interest, means that the ground actually covered is not as extensive as the number of pages indicates.

The material of general interest has been artfully woven into the text and is frequently heightened in interest by quotations from original investigators. These quotations cover a range from Toricelli's account of the making of barometers (p. 65) to Frasch's description of the events when the first sulfur well was put into operation (p. 212), and Loudon's tale of his experiences at the carbon dioxide-filled Valley of Death (p. 492). Other historical matter is included in biographical sketches appearing as legends to pictures of important figures.

In order that the student may separate the 'interesting' material from that which he is supposed to remember, questions are given at the end of each chapter. Emphasis is properly placed upon definitions and there are numerous questions and problems requiring thoughtful applications of known facts to interpret observations and predict results. Statements are made occasionally which must appear confusing to the student, or which may leave him with a wrong impression. Sometimes this comes from the use of a vocabulary which exceeds that of a beginning (especially a beginning non-science) student, as when, in telling what a gas is, the author states that it is not a "continuous elastic fluid." More often it comes from indefinite reference of pronouns, or from the use of phraseology which, while completely obvious to one acquianted with the subject, may mislead the student. On page 257, for example, after indicating that bromine, because of its great chemical activity, does not occur free in nature, the author apparently tells the student that it does occur free in nature, because " . . . the ocean . . . contains about 300,000 tons of bromine per cubic mile of water. This is not a large concentration of bromine. It works out at less than five cents worth of bromine per ton of water to be treated. Nevertheless it is our chief source of bromine." The confusion is compounded by the fact that in the discussion of iodine, a few pages later, it is specifically stated that iodine occurs in sea water as the iodide ion. The largest producer of bromine from sea water has not used for many years the sodium carbonate absorption process described on page 258.

These and similar cases, such as the failure to tell the student why all the atoms pictured in the electronic structures of molecules on page 38ff have two or eight electrons in the outer shell (the rule of eight first appears on p. 305 as part of a discussion of the inert gases), the implication that chemical equilibrium involves the same kind of transfer of molecules between liquid and vapor as that involved in the vapor pressure equilibrium (p. 84), the failure to include in the index, for example, reference to water, or heavy water, or deuterium (deuteron does appear), are perhaps the result to be expected when a single author writes a book which is as all-embracing as a textbook of general chemistry. The organization of a book and the written material appear much clearer to the man who wrote the material than they do to a second individual who has to decide what the first was trying to do from what appears on paper. Turns of phrase which, to a single author through long association or frequent use appear universally understandable, may be caught by a second author whose childhood background and training have been different. The publication could be improved by a critical reading by someone other than the author, and it will be improved in time, if Professor Selwood's students, and particularly the teaching assistants in the course in which the book is used, are sufficiently vocal to make known the things which they object to in the presentation.

FRANK VERHOEK

THE PROBLEM OF SPECIFIC AND SUBSPECIFIC STATUS AND MORPHOLOGIC DEVIATION IN THE ANCIENT MURRELET *SYNTHLIBORHAMPHUS ANTIQUUS (GMELIN)*[1]

FRED H. GLENNY

Department of Zoology and Entomology, The Ohio State University, Columbus 10

The characteristics which are used to designate a species or subspecies and the limits of structure and coloration which may be reasonably employed are points of concern to the taxonomist, systematic zoologist, and geneticist.

It has long been the practice among systematists to accord at least subspecific or variety rank to different color or even geographic variants. In the laboratory, these variants from the normal color are frequently referred to as strains—largely because their antecedents are known. This frequently is not the case with wild species. As a result, not infrequently minor differences in hair or feather coloration have resulted in separation of a species into two or more subspecies. Such differences have value largely in allocating forms to various regions or areas, or as in some instances to special ecological niches, but do not indicate important structural changes in the organism. Furthermore, individuals which are located near the periphery of their distribution, and adjacent to other subspecies of the same organism, may be indistinct from the peripheral population of the adjacent subspecies, with resultant difficulty of determining the different intergrades. Even morphologic characteristics which are reasonably constant in individuals at or near the center of a subspecies population do not necessarily hold for forms throughout the range of distribution—this may be due to variation within a community over a prolonged period of time. This tends to create difficulties in making discrete subspecific determinations.

On the other hand, when a structural difference, within an otherwise established species, does occur and in sufficient numbers to become established in a population, then should this distinctly different morphologic type not be recognized and accorded subspecific rank in the same way as are differences in hair and feather color or pattern? While it is true that skins constitute reasonably good reference materials for subsequent study, anatomical materials can also be preserved for reference or later study. In any event, a constant morphologic characteristic is still an important factor in species evolution and designation just as are colors and patterns of feathers and hair.

In a recent study of alcohol-preserved specimens (U. S. National Museum) of *Synthliborhamphus*, *S. wumizusume* (Temminck) was found to be bicarotidinae normales, but dissection of *S. antiquus* (Gmelin) revealed two morphologic types. Two specimens of *S. antiquus* were bicarotidinae normales (fig. 1), while five specimens were laevocarotidinae (fig. 2). The normally expected arrangement-pattern for the Alcidae is bicarotidinae normales as in the other Charadriiformes (Glenny, 1947, 1948). As a result, the laevo-carotidinae condition is an important deviate from the normal ordinal pattern.

Reference to collecting sites showed that two of the laevocarotidinae specimens came from widely separated regions (Sitka Bay and Amak Island). The rest of the specimens which were examined were collected in "Alaska," but no specific location was designated.

---

[1]Contribution from the Ohio Cooperative Wildlife Research Unit.

Specimens of *S. wumizusume* were collected in Nagasaki Harbor, 30 May 1881. The breeding range for this species is given as the Seven Islands, Japan; and recorded from Sakhalin, Hokkaido, Hondo, Kiusiu and Korea (Peters, 1934).

In contrast, *S. antiquus* has a more extensive range, breeding on the coast of Amurland, Sakhalin, Kamchatka, Kurile, Commander and Aleutian Islands, Kodiak Island and locally south to Sangar Island in the Queen Charlotte Group; and wintering from the Commander and Aleutian Islands south to the China coast, Japan, and southern California.

In a single colony, morphologic deviation might be expected to occur from time to time, and some of these might become sufficiently well established to be recognizable as specific characteristics, but to have the same characteristic become established in a population of such extensive breeding range as *S. antiquus*, and to be able to observe the same variation in forms from widely separated areas of the range, presents something more of a problem in speciation than is presented

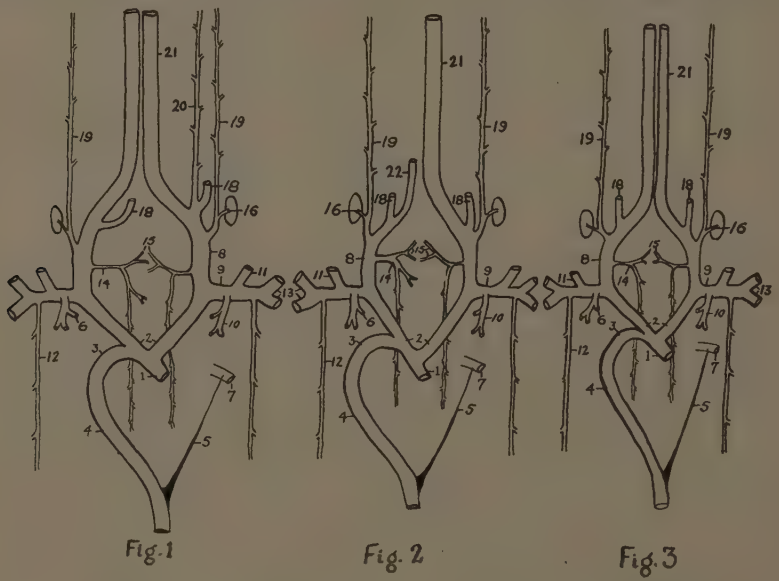


Diagram of the main arteries of the neck and thorax—ventral view.

FIGURE 1. *Synthliboramphus antiquus* B.
FIGURE 2. *Synthliboramphus antiquus* L.
FIGURE 3. *Synthliboramphus wumizusume.*

KEY TO ABBREVIATIONS

1. aortic root
2. innominate arteries
3. right systemic (4th aortic) arch
4. right radix aortae
5. ligamentum aortae
6. sterno-tracheal artery
7. pulmonary artery
8. common carotid artery
9. subclavian artery
10. coracoid major artery
11. axillary artery
12. intercostal artery
13. pectoral arteries
14. ductus shawi
15. syringo-tracheal artery
16. thyroid artery
18. vertebral artery
19. superficial cervical artery
20. accessory cervical artery
21. internal carotid (trunk) artery
22. accessory vertebral artery

by chance variation within a more restricted breeding area such as might occur within a community or within a colony.

It is suggested, therefore, that these two morphologic types be temporarily designated on the basis of the presence of two carotid arteries—bicarotidinae normales—as *S. antiquus B* and one (left) carotid artery—laevo-carotidinae—as *S. antiquus L*, until such a time as other characters may be established to justify further separation of these forms.

It is suggested that additional studies of the skins of these birds, along with anatomical studies, be carried out in an effort to determine whether or not some externally visible characteristic can be utilized on which to separate these two apparent morphologic types.

The writer is convinced that internal structural differences are significant and important in the ultimate designation of specific differences and characteristics just as are externally visible characters of hair and feather coloration and design.

The writer wishes to express his gratitude to Dr. Herbert Friedmann, Curator of Birds, U. S. National Museum, for his help in making this study possible.

REFERENCES

Glenny, F. H. 1947. A systematic study of the main arteries in the region of the heart. AVES XVI. Charadriiformes, Part 1. Ohio Jour. Sci., 47: 152–154.

———. 1948. . . . AVES XVI. Charadriiformes, Part 2. Ohio Jour. Sci., 48: 194–198.

Peters, J. L. 1934. Check-list of Birds of the World. Harvard Univ. Press, Cambridge, Mass. (Vol. II, p. 356).

Logic for Living. Lectures of 1921–22 by Henry Horace Williams. *Jane Ross Hammer* (Ed.) Philosophical Library, New York. 1951. xix+275 pp. $3.75.

Here is a book written or edited from stenographic reports of the brilliant lectures and class-room discussions conducted in 1921–22 by Henry Horace Williams, Professor of Philosophy for fifty years (1891–1941) at the University of North Carolina.

Henry Horace Williams was part of the Hegelian movement which exerted a powerful influence upon American thought in that era. Hegelianism broke with fundamentalism and all theological authority. Its method was the interpretation of experience by reason. But its chief aim was to vindicate religious beliefs closely similar to the traditional ones in God, free-will, and immortality. It respected science but would not take science as a guide in thinking. It admitted the truth of Darwinian evolution, but it drew none of the important conclusions, indicated by that doctrine, about the biological basis of the spiritual life of man, or about his precarious status in the universe.

Hegelianism was tremendously important in weakening the hold of authoritarian fundamentalism upon the universities, and thus in creating a situation where a truly scientific philosophy could develop. This is what Horace Williams did in North Carolina through the teaching which is reported in the present volume. His influence prevented the passage of an anti-evolution law in that state, and was a major factor in the cultural and intellectual awakening that has occurred there since 1900.

The volume before us is a noble tribute to a great teacher and a great man. But its contribution to our knowledge of philosophical or of scientific truth is seriously questioned.

GARDNER WILLIAMS

STUDIES OF THE GENUS *KUNZEANA*. *II*. EIGHT NEW SPECIES OF MEXICAN *KUNZEANA*

ROBERT F. RUPPEL AND DWIGHT M. DeLONG
Department of Zoology and Entomology, The Ohio State University, Columbus 10

In a previous paper (Ruppel and DeLong, 1951), five new species of Mexican *Kunzeana* were described. It treated those forms which have the shortest heads and in which the vertex is one-half to two-thirds as long as its basal width. Also in that group the male aedeagus has either no or few processes arising from it and these are at the middle or more apical portion of the phalicata.

The species described at this time are related to *kunzei* and also allied to *lenta*, *furcata*, and *texana*, all of which have been taken in Mexico. The male adeagus in these species shows a greater diversity and number of aedeagus processes, many of which arise from near the base.

The types of all species described in the following descriptions are in the DeLong collection.

Kunzeana flavella n. sp.

Resembling *kunzei* (Gillette) in general form and appearance but with distinctive coloration and genitalia. Length 2.3 mm.

The vertex is bluntly rounded at its apex and its median length is about two-thirds as great as its basal width between the eyes.

Color: The vertex is light cream marked with a few irregular orange lines on its disk with a pair of large orange spots near its apex. The face is dull orange with its genae and lora dull cream. The pronotum is bright yellowish-orange bordered anteriorly with a broad ivory band which bears large orange spots. The scutellum is light cream with its apex, basal angles, and a pair of short, longitudinal, median lines orange. The elytra are bright yellow with a stripe along each claval suture, a stripe between the sectors, and the distal third of the costal margins, semi-hyaline.

Genitalia: The posterior margin of the seventh abdominal sternite of the female is nearly truncate with its lateral angles rounded. The plates, styles, and pygofers of the male are similar to those of *kunzei*. The pygofer hooks arise on the dorso-caudal angles of the pygofers and curve sharply ventrad at their apices. A pair of flat, lateral processes arise on the base of the aedeagus and extend to near the middle of the phalicata. These processes narrow suddenly near their apices and the thin apical portions extend caudo-laterally. The phalicata is rather spindle-shaped and pointed at its apex.

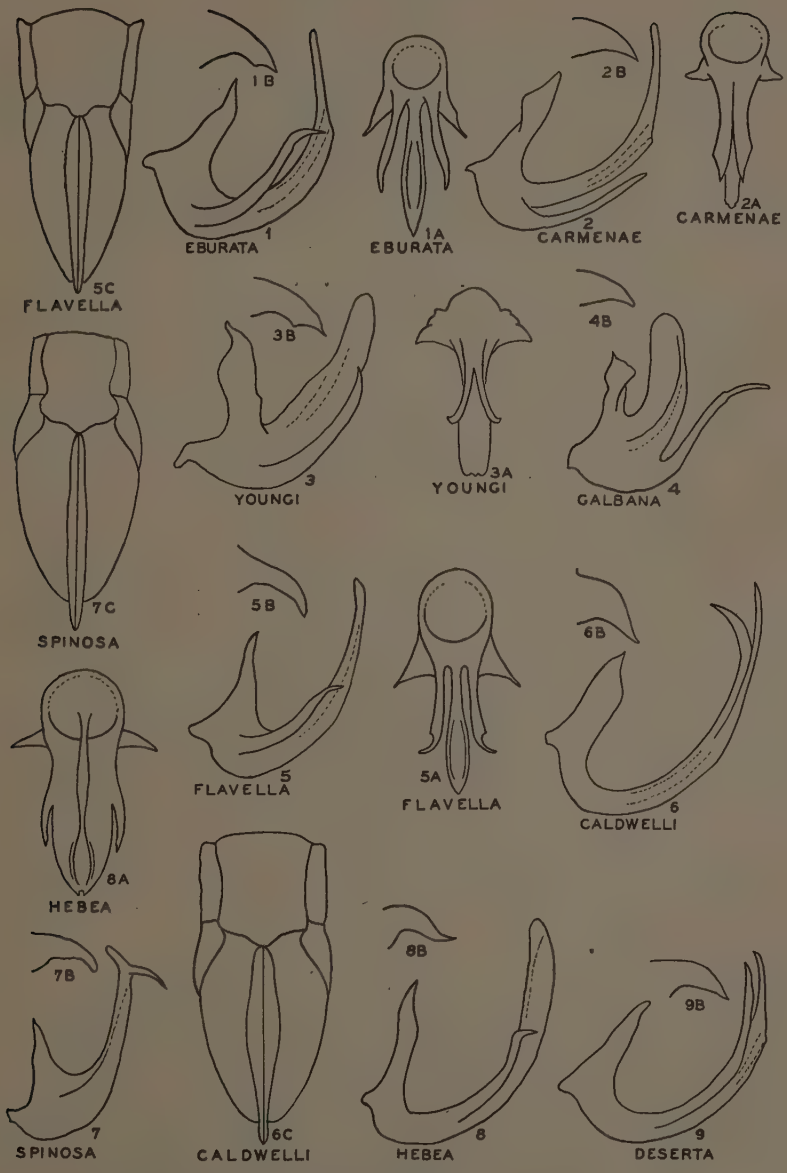
Holotype male and allotype female collected at Colima, Huerta Alverez, Mex., Jan. 27, 1930 (M.B. 296) by Dr. Dampf; male paratype at Navajoa, Sor., March 16, 1927 (M.B. 204) by Dr. Dampf; male paratype, Iguala, G'ro., Sept. 11, 1939, by DeLong; male paratype, Mezcala, G'ro., Aug. 4, 1930, (M.F. 1935) by Parra; male paratype, Cocula, G'ro., Aug. 6, 1930, (M.F. 1753) by Dampf; male paratype, Tetela del Rio, G'ro., Aug. 13, 1930, (M.F. 1757) by Parra; male paratype Chilpancingo, G'ro., Oct. 25, 1941, by DeLong and Good; male paratypes, Chilpancingo, G'ro., July 16, 1929 (M.B. 291) by Dampf.

Kunzeana galbana n. sp.

Resembling *flavella* in general form and appearance but with distinctive male genitalia. Length 2.5 mm.

The vertex is bluntly angled at its apex and its median length is about two-thirds as great as its basal width between the eyes.

Color: The vertex is cream heavily mottled on its disk with dull orange. The face is rather dusky orange with its genae and lora dull cream. The pronotum is light yellow-green bordered



1, 2, 3, 4, 5, 6, 7, 8, 9. Aedeagus (lateral view).
1a, 2a, 3a, 5a, 8a. Aedeagus (ventral view).
1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b, 9b. Pygofer hook (lateral view).
5c, 6c, 7c. Female seventh sternite and pygofers.

anteriorly with an ivory band which bears about six elongate, longitudinal spots. The scutellum is dull ivory with a pair of short, median, longitudinal lines, its apex, and its basal angles, orange. The elytra are bright yellow with the margins of the clavus and the apical cells semi-hyaline.

Genitalia: The plates, styles, and pygofers of the male are similar to those of *flavella*. The pygofer hooks arise on the dorso-caudal angles of the pygofers and are rather broad and blunt. The base of the aedeagus is long and broad with its dorsal processes rather thick. A long, recurved, ventral process arises on the base and extends dorso-caudad. The phalicata is broad at its base and tapers to its rounded apex.

Holotype male and male paratype collected at Balsas, G'ro., Dec. 11, 1929 (M.F. 1501) by Dr. Dampf; male paratype, Mezcala, G'ro., Dec. 13, 1929 (M.F. 1512) by Dampf; male paratype, Paso de Ixtla, Mor., July 30, 1930 (M.F. 1738) by J. Parra.

Kunzeana eburata n. sp.

Resembling *flavella* in general form and appearance but with distinctive genitalia. Length 2.3 mm.

The head is bluntly rounded at its apex with its median length about two-thirds as great as its basal width between the eyes.

Color: The vertex is light cream marked with fine, irregular orange lines on its disk and with a pair of large orange spots near its apex. The face is light tan with its genae and lora light cream. The pronotum is dull greenish-yellow bordered anteriorly with a broad ivory band which bears some elongate orange spots. The scutellum is ivory with its apex, basal angles, and a pair of small spots on its disks, light orange. The elytra are translucent yellowish orange with their apical halves semi-hyaline.

Genitalia: The plates, styles, and pygofers of the male are similar to those of *flavella*. The pygofer hooks arise on the dorso-caudal angle of the pygofer, and are sharply pointed and recurved. A pair of lateral processes, widely separated at their bases, arise on the base of the aedeagus and extend to near the middle of the phalicata. These processes extend parallel to the phalicata to near their apices where they turn suddenly caudad. The phalicata is moderately broad and somewhat spindle-shaped.

Holotype male and male paratypes collected at San Geronimo, G'ro., Aug. 30, 1930 (M.F. 1787) by J. Parra; male paratype, Cuernavaca, Mor., Sept. 11, 1939, by DeLong and Plummer; Zincauro, G'ro., Sept. 2, 1930 (M.F. 1789) by Parra; Pungarabato, G'ro., Aug. 30, 1930 (M.F. 1769) by Parra; Iguala, G'ro., Sept. 11, 1939, by DeLong; Coyoca-Catalan, G'ro., Aug. 24, 1930 (M.F. 1771) by Parra; Iguala, G'ro., Oct. 25, 1941, by DeLong and Good; Chilpancingo, G'ro., Oct. 25, 1941, by DeLong, Good, Caldwell, and Plummer; Balsas, G'ro., Dec. 11, 1929 (M.F. 1501) by Dampf.

Kunzeana caldwelli n. sp.

Resembling *kunzei* (Gillette) in general form and appearance but with distinctive coloration and genitalia. Length 2.4 mm.

The vertex is rounded at its apex and its median length is about two-thirds as great as its basal width between the eyes.

Color: The vertex is cream bordered anteriorly with a dull ivory band and mottled on its disk with light orange markings. The face is dusky tan with its genae and lora cream. The pronotum is yellowish green with a narrow, light orange band and scattered cream spots on its anterior margin. The scutellum is reddish-orange. The elytra are semi-hyaline with the veins and the disk of each clavus and corium, golden yellow. The elytra of the allotype female differs from the others in the series at hand in being rosy red with semi-hyaline apical cells.

Genitalia: The posterior margin of the seventh abdominal sternite of the female is nearly truncate with its median quarter produced into a short lobe. The plates, styles, and pygofers of the male are similar to those of *kunzei*. The pygofer hooks arise on the dorso-caudal angle of the pygofers, are strongly curved and sharply pointed. A pair of thin, sharply pointed ventro-lateral processes arise near the middle of the phalicata and extend parallel to the phalicata to slightly above its apex. The phalicata is long and slender.

Holotype male, allotype female, male and female paratypes collected at Valles, S. L. P., Sept. 24, 1941, by DeLong, Good, Caldwell, and Plummer.

Kunzeana youngi n. sp.

Resembling *texana* (Beamer) in form and general appearance but with distinctive genitalia. Length 2.7 mm.

The vertex is produced for about one-half of its length in front of the eyes, its anterior margin is bluntly angled at the apex, and its median length is about two-thirds as great as its basal width between the eyes.

Color: The vertex is cream bordered anteriorly with a broad, ivory band and mottled on its disk with dull orange markings. The face is brownish orange with its genae and lora dull cream. The pronotum is golden orange bordered anteriorly with a broad, ivory band which bears large orange spots. The scutellum is dull ivory with its apex and basal angles orange brown. The elytra are semi-hyaline with translucent, yellowish-orange stripes along their costal margins and veins.

Genitalia: The plates, styles, and pygofers of the male are similar to those of *texana*. The base of the aedeagus is moderately broad with its dorsal processes rather thick. The phalicata is rather thick at its base and tapers to a narrow, blunt apex and bears a pair of short, thin ventro-lateral processes closely appressed to its basal half.

Holotype male collected at Hacienda Fresno, Coah., June 11, 1931 (M.B. 328) by Dr. Dampf. The authors wish to express their gratitude to Mr. David A. Young for the "checking with types" of this and other material which were sent to him.

Kunzeana hebea n. sp.

Resembling *kunzei* (Gillette) in form and general appearance but much drabber in coloration and with distinctive genitalia. Length 2.5 mm.

The vertex is bluntly rounded at its apex with its median length about two-thirds as great as its basal width between the eyes.

Color: The vertex is dark cream bordered anteriorly with a broad ivory band and heavily mottled on its disk with orange tan markings. The face is light tan with its genae and lora cream. The pronotum is dull orange-brown bordered anteriorly with a dull ivory band which bears scattered, dull orange spots. The scutellum is cream with its apex, basal angles, and its disk, dull orange. The elytra are dull orange on their basal half with their distal half smoky.

Genitalia: The plates, styles, and pygofers of the male are similar to those of *kunzei*. The sharply pointed, recurved pygofer hooks arise on the dorso-caudal angles of the pygofers. A pair of thin, lateral processes arise on the base of the aedeagus and extend to near the distal third of the phalicata. These processes parallel the phalicata to near the apices where they turn suddenly caudad to terminate in sharply pointed apices. The phalicata is broad and flat and tapers to a pointed apex.

Holotype male and male paratypes collected at Iguala, G'ro., Sept. 11, 1939, by D. M. DeLong; male paratypes, Iguala, G'ro., Oct. 25, 1941, by DeLong and Good; male paratype, Arcelia, G'ro., Aug. 19, 1930 (M.F. 1760) by J. Parra.

Kunzeana deserta n. sp.

Resembling *hebea* in general form but with distinctive coloration and genitalia. Length 2.3 mm.

The vertex is broadly rounded on its anterior margin and its median length is about two-thirds as great as its basal width between the eyes.

Color: The vertex is orange-red bordered anteriorly with a broad, dull ivory band and with a cream spot near the middle of the inner margin of each eye. The face is orange-tan with the genae and lora dull cream. The pronotum is reddish-orange with a narrow, dull orange band and a few ivory spots along its anterior margin. The scutellum is orange-red. The elytra are golden orange with their apical cells and the distal third of their costal margins, semi-hyaline.

Genitalia: The plates, styles, and pygofers of the male are similar to those of *hebea*. The pygofer hooks arise on the dorso-caudal angles of the pygofers, are strongly curved, and taper from thick bases to sharply-pointed apices. A pair of thin, sharply pointed, lateral processes arise near the base of the phalicata and extend parallel to the phalicata to near its apex. The phalicata is long and slender.

Holotype male collected at Granja Experimental Rodriguez, Nuevo Leon, June 5, 1931 (M.F. 2029) by Dr. Dampf.

Kunzeana carmenae n. sp.

Resembling *hebea* in general form but with distinctive coloration and genitalia. Length 2.5 mm.

The vertex is broadly rounded on its anterior margin and its median length is about two-thirds as great as its basal width between the eyes.

Color: The vertex is reddish orange bordered anteriorly with a broad ivory band and flecked on its disk with a few ivory spots. The face is orange tan with its genae and lora dull cream. The pronotum is greenish-yellow bordered anteriorly with a dull orange band which bears small, scattered, cream spots. The scutellum is dull orange. The elytra are yellowish orange with a stripe along each claval suture and their apical cells, semi-hyaline.

Genitalia: The plates, styles, and pygofers of the male are similar to those of *hebea*. The pygofer hooks arise on the dorso-caudal angle of the pygofers and are rather thick. The base of the aedeagus is rather long and broad with its dorsal processes long. A pair of thin, ventro-lateral processes arise on the base and extend caudad to near the middle of the phalicata. The phalicata is long and slender.

Holotype male collected at Carmen, Camp., Jan. 24, 1939 (M.F. 8398) by Dr. Dampf; male paratype Tierra Blanca, Veracruz, July 29, 1932 (M.F. 2655) by Dampf.

Kunzeana spinosa n. sp.

Resembling *kunzei* (Gillette) in form and general appearance, but with distinctive coloration and genitalia. Length 2.5 mm.

The vertex is produced for about one-half of its length in front of the eyes, its anterior margin is rounded, and its median length is about two-thirds as great as its basal width between the eyes.

Color: The vertex is dull ivory marked with irregular orange lines. The face is brownish-orange with a bluish bloom on its lower portion. The pronotum is dull yellowish-orange bordered anteriorly with a broad ivory band which bears large, orange spots. The scutellum is dull ivory with its apex and basal angles yellowish-orange. The elytra are golden yellow with the margins of each clavus, the areas between the first and second sectors, and the apical cells, semi-hyaline.

Genitalia: The posterior margin of the seventh abdominal sternite of the female is conically produced into a sharply pointed lobe. The plates, styles, and pygofers of the male are similar to those of *kunzei*. The pygofer hooks arise on the dorso-caudal angle of the pygofer and taper from their thick bases to sharply pointed apices. The base of the aedeagus is rather narrow with its dorsal processes long, thin, and widely separated at their apices. The phalicata is rather slender and bears a pair of terminal, sharply pointed processes.

Holoytpe male, allotype female, male and female paratypes collected at Rancho Monter, Oax., Dec. 16, 1937 (M.F. 6403) by Dr. Dampf.

REFERENCE

Ruppel, R. F., and **D. M. DeLong.** 1951. Studies of the genus *Kunzeana*. I. Ohio Jour. Sci., 51: 187–191.

Inorganic Syntheses. Volume III. *L. F. Audrieth*, Editor. McGraw-Hill Book Company, Inc., New York. 1950. xi+230 pp. $3.75.

The third volume of this highly useful and important series continues the policies and practices followed in volumes I and II. The procedures submitted by various contributors are carefully checked at some other laboratory, revised and edited if necessary, and then returned to the original contributor for final approval. There are over sixty new preparations listed, including such compounds as the basic beryllium derivatives of organic acids, strontium sulfide and selenide phosphors, boron chloride and bromide, a variety of organo-silicon compounds, nitrogen (V) oxide, a series of polyphosphates, and a variety of transition metal halides and oxides. Modern principles of nomenclature are followed in most cases, although widely used trivial and common names are used in some instances. A cumulative index to all three volumes is provided.

The work which is being done by the editors and contributors to this series of volumes represents an outstanding contribution to chemical research and deserves the enthusiastic support and appreciation of chemists generally and of inorganic chemists in particular.

HARRY H. SISLER.

ANNUAL REPORT OF THE OHIO ACADEMY OF SCIENCE
1952

Organized 1891 Incorporated 1892
Affiliated with the American Association for the Advancement of Science

OFFICERS AND COMMITTEES FOR 1952–1953

President
GLENN W. BLAYDES

Vice-Presidents

A. *Zoology:* W. C. KRAATZ
B. *Plant Sciences:* H. C. EYSTER
C. *Geology:* R. P. GOLDTHWAIT
D. *Medical Sciences:* G. J. HAMWI
E. *Psychology:* G. A. KELLEY
F. *Physics and Astronomy:* W. R. KOCH
G. *Geography:* C. L. DOW
H. *Chemistry:* E. R. CALEY
I. *Mathematics:* LUTHER SHETLER
J. *Science Education:* CECIL RISER
K. *Anthropology and Sociology:* W. H. SASSAMAN
L. *Conservation:* F. H. GLENNY

Secretary
RUSH ELLIOTT

Treasurer
R. M. GEIST

Historian
W. H. ALEXANDER

COMMITTEES

Executive Committee
Ex-officio: G. W. BLAYDES, RUSH ELLIOTT, R. M. GEIST
Elective: R. A. POPHAM AND W. H. SHIDELER

Membership

A. *Zoology:* ALVAH PETERSON
B. *Plant Sciences:* ELTON PADDOCK
G. *Geology:* H. F. DONNER
D. *Medical Sciences:* H. G. SCHLUMBERGER
E. *Psychology:*
F. *Physics and Astronomy:* W. H. SHAFFER
G. *Geography:* MILDRED DANKLEFSEN
H. *Chemistry:* D. R. CLIPPINGER
I. *Mathematics:* L. L. LOWENSTEIN
J. *Science Education:* C. E. HOEL
K. *Anthropology and Sociology:* A. C. MAHR
L. *Conservation:* C. S. JOHNSON

Nominating
VICE-PRESIDENTS of 1951–1952, A. N. SOLBERG, Chairman

Program
VICE-PRESIDENTS AND SECRETARY

Election of Fellows
VICE-PRESIDENTS AND SECRETARY

Library
ACADEMY LIBRARIAN, MORTON COBURN, Chairman
W. M. TIDD.....Term expires 1953
W. C. BEAVER.....Term expires 1955

Publications
SECRETARY, Chairman
W. M. TIDD.....Term expires 1953
W. C. BEAVER.....Term expires 1955

Resolutions
A. W. LINDSEY, Chairman Term expires 1953
G. B. BARBOUR.....Term expires 1954
W. A. MANUEL.....Term expires 1955

Necrology
H. H. M. BOWMAN, Chairman, Term expires 1953
A. E. WALLER.....Term expires 1954
J. H. MELVIN.....Term expires 1955

Trustees of Research Fund
G. B. BARBOUR, Chairman, Term expires 1953
K. G. A. BUSCH.....Term expires 1954
E. S. THOMAS.....Term expires 1955

Academy Representatives

1. On the Joint Administrative Board of the Ohio Journal of Science:
   W. M. Tidd.....Term expires 1953
   W. C. Beaver.....Term expires 1955
2. On the Council of the A. A. A. S.: Guybert P. Cahoon.

The Council for 1952–1953

G. W. Blaydes	E. L. Green	R. A. Popham
G. B. Barbour	R. P. Goldthwait	Alvah Peterson
W. C. Beaver	F. H. Glenny	Elton Paddock
Morton Coburn	G. J. Hamwi	Cecil Riser
E. R. Caley	C. E. Hoel	W. H. Shideler
D. R. Clippinger	C. S. Johnson	Luther Shetler
C. L. Dow	W. C. Kraatz	W. H. Sassaman
H. F. Donner	G. A. Kelley	H. G. Schlumberger
Mildred Danklefsen	W. R. Koch	W. H. Shaffer
Rush Elliott	F. H. Krecker	E. S. Thomas
H. C. Eyster	L. L. Lowenstein	W. M. Tidd
R. M. Geist	A. C. Mahr	J. N. Wolfe

REPORT OF THE SIXTY-FIRST ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

The sixty-first annual meeting was held on the campus of Kent State University, our first meeting on this campus, on April 17, 18 and 19. Excellent facilities were made available for all phases of the program. Registration for the Senior Academy was almost 600, and there are always many in attendance who fail to register.

Programs were presented by all sections of the Academy, except Psychology, the newly-formed section in Conservation meeting for the first time with a full program and excellent attendance. An early morning "Bird Walk" and a Geology field trip were held on Saturday. The fourth Annual Science Day of the Junior Academy was the largest and most successful of any to date, there being 175 exhibits presented. Commercial exhibits, which are becoming a more important part of the meeting each year, were made by seventeen companies.

The annual banquet and business meeting were held in the Student Union ballroom on Friday evening at 6:30. Dr. H. F. Raup served as toastmaster and Dean R. L. Clark extended greetings from Kent State University. Dr. E. S. Thomas gave the response for the Academy. The presidential address by Dr. W. H. Shideler was titled, "Paleontology and Evolution."

The annual report of the Secretary which summarized the past year's activities included a report on members added, there having been 276 new individual memberships, six new Corporation Memberships and nine new Institution Memberships.

The following persons were announced as newly elected Fellows of the Academy:

A. C. Barnes	A. J. Hammer	Eric Ogden
H. D. Brown	W. D. Hamrick	W. P. Porter
Mrs. L. D. Coulter	G. J. Hamwi	E. M. Redding
H. A. Cunningham	C. H. Hobbs	C. V. Riley
G. DeLoache	N. W. Hovey	H. G. Schlumberger
L. P. Eblin	K. W. Hunt	H. C. Seibert
E. H. Ellison	F. L. James	R. W. Stacy
J. W. Gebhart	C. S. Johnson	Violet R. Strahler
F. H. Glenny	T. J. Johnson	R. L. Walp
E. E. Good	K. P. Klassen	G. P. Zimmer
	A. G. McQuate	

The membership approved amendments to provide for the formation of a Section on Conservation and the discontinuance of the Conservation Committee; for membership to become effective immediately upon receipt of the application and dues; and for certain changes in the election of Fellows.

Dr. F. H. Krecker, secretary of the Junior Academy, announced that the awards for outstanding high school teachers were being presented to Mrs. L. D. Coulter, Crestview Junior High School, Columbus; Daniel C. Fast, North Baltimore; Fred W. Fox, McGuffey High School, Oxford; Asa Haskins, Pomeroy; and Alfred G. Linschied, Shaker Heights.

The Ohio Journal of Science Award for Excellence in Research was presented to a member of the Chemistry Section this year, the award going to Dr. E. R. Caley of Ohio State Uni-

versity. The award was presented by Dr. B. M. Norton, vice-president of the Chemistry Section.

The report of the Necrology Committee was presented by Dr. H. H. M. Bowman, of the Nominating Committee by Dr. J. O. Fuller and of the Resolutions Committee by Dr. H. R. Eggleston.

Respectfully submitted,

RUSH ELLIOTT, *Secretary.*

REPORT OF THE EXECUTIVE COMMITTEE AND COUNCIL

The Executive Committee met on November 30, 1951, and again on April 17, 1952, and the Council on December 1, 1951, and again on April 17, 1952.

The Council approved the appointment of Morton Coburn as the Academy Librarian.

The preparation of certain amendments to the Constitution and By-Laws by the Secretary was authorized. These have been referred to in the Report on the Annual Meeting.

The Council accepted with regret the resignation of Dr. Eugene Van Cleef as chairman of a special committee on Corporation Memberships. Dr. Van Cleef has done an outstanding job in initiating a plan for Corporation and Institution Memberships and in securing Corporation Memberships. A resolution of thanks for Dr. Van Cleef was voted by the Council.

A special committee on "Ohio Flora" (Dr. Lucy Braun, chairman, Dr. G. W. Blaydes, Dr. J. A. Herrick, Dr. E. S. Thomas and Dr. J. N. Wolfe) has been at work during the year and reports considerable progress to date.

The Council passed a motion that the incoming President appoint a person to serve as Public Relations Director for the Academy.

The 1953 Annual Meeting is to be held at Ohio State University on April 23, 24 and 25; the 1954 meeting as a part of the sesquicentennial program of Ohio University on April 15, 16 and 17; the 1955 meeting at Ohio Wesleyan University and the 1956 meeting at Bowling Green State University.

Respectfully submitted,

RUSH ELLIOTT, *Secretary.*

REPORT OF THE TREASURER

COLUMBUS, OHIO, April 18, 1952.

To the Ohio Academy of Science:

I submit herewith a financial statement of the condition of The Ohio Academy of Science as of December 31, 1951. The books have been audited and the opinion of the auditor is herewith attached.

Respectfully submitted,

ROBERT M. GEIST, *Treasurer.*

OHIO ACADEMY OF SCIENCE STATEMENT OF INCOME AND EXPENSE

For the year ending December 31, 1951

CURRENT EXPENSE FUND

INCOME:

Membership dues 1951 and prior years	$3,666.50	
Sale of publications	36.73	
Interest on U. S. Savings Bonds	47.50	
Treasurer, Ohio Psychological Association	25.00	
Total Income		$3,775.73

EXPENSES:

Subscriptions and Engraving (Journal)	$2,249.63	
Printing News Letters, Junior Academy	128.50	
Printing Annual Report	101.88	
Postage, Printing, Bank Charges, Office Expense, Auditing, etc.	1,217.07	
Total Expense		3,697.08
Excess of Income over Expenses		$ 78.65

RESEARCH FUND

INCOME:		
Interest on Bonds	$ 59.50	
Dividends on Stock	25.00	
Grant, A.A.A.S.	270.50	
		$ 355.00
EXPENSES:		
Grant—Ethel M. Miller	$ 100.00	
Grant—Elizabeth W. Smith	70.50	
Grant E. Lucy Braun, Ohio Flora	200.00	
Bank Charges	1.28	
		371.78
Excess *Expenses* over Income		$ 16.78

CASH BALANCES

CURRENT EXPENSE FUND	
Cash Balance—January 1, 1951	$ 997.38
Net Cash Receipts	3,820.98
	$4,818.36
Less: Expenses	3,697.08
Cash Balance—December 31, 1951	$1,121.28
RESEARCH FUND:	
Cash Balance—January 1, 1951	$ 331.81
Net Receipts	355.00
	$ 686.81
Less: Expenses	371.78
	$ 315.03
Less: Academy money deposited	23.75
Cash Balance—December 31, 1951	$ 291.28

AUDITOR'S CERTIFICATE

January 25, 1952.

The Ohio Academy of Science, Columbus, Ohio.

GENTLEMEN:

In accordance with your request, we have audited the records of the Treasurer of The Ohio Academy of Science for the year ended December 31, 1951.

All recorded cash receipts were traced to the bank and found to have been deposited intact. Cancelled checks were on file for all disbursements and were examined. Cash balances were verified by certificates obtained from the banks.

The securities held in the two funds were verified by examination and the income therefrom properly accounted for. The securities are held in a safety deposit box at The Huntington National Bank.

In my opinion, based on such examination the statements presented herewith present the financial condition of The Ohio Academy of Science as of December 31, 1951, and the transactions for the year January 1, 1951, to December 31, 1951.

Respectfully submitted,

JESSE H. BALDWIN.

REPORT OF THE TRUSTEES OF THE RESEARCH FUND

To the Ohio Academy of Science:

The Trustees of the Research Fund present the following report of receipts and expenditures during the past year.

TECEIPTS:		
Bank balance on January 1, 1951	$310.38	
Income from Investments	84.50	
A.A.A.S. Grant (1950)	270.50	
A.A.A.S. Grant (1951)	248.00	
Income January 1 to April 10, 1952	12.50	
Total income and balance forwarded		$925.88

EXPENDITURES:

Grant to Mrs. Ethel Miller to help defray costs of Index to the *Ohio Naturalist* and *Ohio Journal of Science*	$100.00
Grant to Miss Elizabeth W. Smith, Kent State U., "Research on Endocrinology in Bats"	70.50
Grant to Committee on "Flora of Ohio," Dr. E. Lucy Braun, U. of Cincinnati, Chairman (1951 Grant)	200.00
Grant to Miss Janice C. Beatley, Ohio State U., to aid in research project, "The Primary Vegetation of Jackson and Vinton Counties"	60.00
Grant to Committee on "Flora of Ohio," Dr. E. Lucy Braun, U. of Cincinnati, Chairman (1952 Grant)	188.00
Grant to William Adams, Jr., Muskingum College, for study of "Ferns and Fern Allies of SE Ohio"	100.00
Bank charges	2.32
Total Expenditures	720.82
Balance on hand, April 10, 1952	$205.06

Respectfully submitted,

K. G. A. BUSCH,
HERBERT OSBORN,
GEORGE B. BARBOUR, *Chairman.*

REPORT OF THE LIBRARIAN

The library is pleased to inform the Academy that its official journal is used in four hundred exchanges. Seventy percent of these exchanges are with public and private institutions in fifty-nine foreign countries. Thirty percent of the exchanges are with domestic institutions in forty-one states.

In many instances we receive two or three publications in exchange for the Journal of Science.

The largest number of foreign exchanges are with the following countries:

Argentina	12
Australia	15
Brazil	12
Canada	14
England	15
France	10
Italy	27
Japan	10
Spain	14
U. S. S. R.	13

Thirty-two new exchanges have been added since September 1, 1951.

Sales of the Academy's publications for the year 1951 amounted to nineteen dollars and fifty cents ($19.50). This sum was turned over to the Treasurer of the Academy.

Respectfully submitted,

MORTON COBURN, *Librarian.*

REPORT OF THE JOINT ADMINISTRATIVE BOARD OF THE OHIO JOURNAL OF SCIENCE

The annual meeting of the Joint Administrative Board of the Ohio Journal of Science was held in Columbus, April 5, 1952. Present were Drs. Spieker and Meyer representing The Ohio State University, Drs. Tidd and Beaver representing The Ohio Academy of Science, and Drs. Green and Popham of the Ohio Journal of Science staff.

Dr. Spieker was re-elected to serve as Chairman of the Board. The minutes of the preceding meeting were read and approved.

The report of the Business Manager was mainly in the form of a financial statement for Volume 51, a copy of which is attached to this report. The report was accepted and filed.

The report of the Editor was read, accepted and an expression of confidence in the work of the Editor was ordered to be recorded in the minutes.

Following a discussion of the Ohio Journal of Science Award for Excellence in Research, lots were drawn and the section of Zoology was chosen as the field in which the award would be offered in the year 1952–53. The Board authorized the Editor to make necessary changes in the rules and regulations of the award contest to conform with the stipulation that all authors must be members of the Zoology section of the Academy.

A proposal by Dr. C. M. Wilson, the Book Review Editor, to establish a Book Notice Section as a regular feature of the Journal was carefully considered. The Board decided that the book review notices would be more frequently read if they remained scattered throughout the Journal and, in addition, the cost of printing would be held to a minimum in so doing.

The office of Associate Editor was established. The Board ruled that the duties of Associate Editor shall be to function when called upon by the Editor to do so. Dr. Green was empowered to select an Associate Editor subject to the approval of the Board at its next meeting.

The following staff of the Journal was elected by the Board to serve in the year 1952–53: Dr. E. L. Green, Editor; Dr. R. H. Bohning, Advertising Manager; Dr. R. A. Popham, Business Manager.

Dr. Spieker read the report of the auditors of the books of the Ohio Journal of Science for Volume 50, and announced that auditors found the accounts to be in order. The report of the auditors was accepted and filed.

A rather lengthy discussion ensued in which the matter of income to the Journal was discussed. The Business Manager was instructed to attempt to obtain an increase in the income budget for the year 1952–53.

There being no further business, the Board adjourned on a motion by Dr. Meyer, seconded by Dr. Beaver.

Respectfully submitted,

RICHARD A. POPHAM,
Secretary of the Board.

THE OHIO JOURNAL OF SCIENCE

Fiscal Year 1951

(Volume 51, Fiscal Year, January 18, 1951, to December 25, 1951)

RECEIPTS

Bank Balance, January 18, 1951	$1,107.19
Ohio State University—Paid for subscriptions	1,800.00
Ohio Academy of Science—Paid for subscriptions	1,807.50
Non-members—Paid for subscriptions	404.50
Sale of separate numbers, volumes, and reprints	514.48
O.A.S.—Paid for one-half cost of plates	421.63
Ohio Academy of Science—Paid for Annual Report	101.88
Miscellaneous	0.00
Advertisements	1,116.97
	$7,274.15

EXPENDITURES

Spahr and Glenn—Printing Journal	$4,326.61
Spahr and Glenn—Reprints	46.06
Mailing Envelopes	180.91
Advertising the O.J.S.	75.00
Bucher Engraving—Plates	832.41
Postage and Express	211.99
Office Supplies and Bank Charges	108.67
Refunds	3.00
Secretary and Labor	118.86
Bank Balance, December 25, 1951	1,370.64
	$7,274.15

REPORT OF THE COMMITTEE ON NECROLOGY

The Necrology Committee has the sad duty of reporting the passing of eleven of our members during the period from April 1, 1951, to April 1, 1952.

Respectfully submitted,

H. H. M. BOWMAN, *Chairman.*

BERNICE GIEBNER

Miss Bernice Giebner, Professor of Biology at Jamestown Community College and member of the Botany Section since 1930.

Miss Giebner was born at Columbus, Ohio, on May 8, 1903, and after attending public schools in Columbus entered Ohio State University and was graduated with the B.Sc. degree in 1927. This was followed by a Master of Arts degree in 1941. From 1928 to 1943 she taught

science at Dana Avenue School in Columbus. From 1941 to 1943 she was research assistant to Dr. Meyer at Ohio State University and from 1943 to her death in 1952 was Assistant Professor at the Jamestown College.

She was a member of Sigma Xi, the Ohio and the New York Academy of Sciences, as well as the A.A.A.S. Her researches on the algae of Lake Chautauqua, N. Y., will be published during 1952. She died of coronary disease on March 1st, 1952, at Jamestown, N. Y., and was buried in Columbus, Ohio.

Herbert Albert Hoster

Dr. Herman Albert Hoster, Professor of Medicine and Medical Research at Ohio State University and member of Section D—Medical Science, since 1941.

Dr. Hoster was born in Columbus, Ohio on March 5, 1912, and later attended Yale University, from which he was graduated with the A.B. degree in 1934. He next went to Johns Hopkins Medical School and secured the M.D. degree in 1938. In 1938 he married Margaret Prentiss and after a divorce he married Marion E. Shanley in 1947. He is the father of two sons, Frederick Williams and Albert Stanton Hoster.

He held the following positions: Intern and Resident Staff, Jefferson Medical College Hospital, 1938–40; Research Fellow, Yale University School of Medicine, Department of Physiological Chem., 1940–41; Instructor, Department of Medicine, The Ohio State University, 1941–44; Assistant Professor, Department of Medicine, The Ohio State University, 1944–46; Associate Director, Division of Cancer Research, 1945; Associate Professor, Department of Medicine, The Ohio State University, 1946–47; Research Advisory, The Ohio State University Tumor Clinic and Columbus Cancer Clinic, 1946–1951; Professor and Coordinator of Oncology, Professor of Medicine, Department of Medicine, The Ohio State University, 1947–1951; Research Director, Columbus Cancer Center, laboratories and tumor registry, 1947–1951; President, The Hodgkin's Disease Research Foundation, Inc., 1947–1951.

He was a member of the following learned societies: American Association for the Advancement of Science; American Association for Cancer Research; American Chemical Society; American Medical Association; Columbus Academy of Medicine; Hodgkin's Disease Research Foundation (charter member); New York Academy of Medicine; Ohio Academy of Science; Ohio State Medical Association; Xigma Xi; Society for the Study of Experimental Biology and Medicine; Tissue Culture Association.

He served in the following boards: Member, Board of Directors, Columbus Cancer Clinic; Member, Board of Franklin County Unit of American Cancer Society; Executive Secretary, Research Advisory Committee on Cancer; Medical Advisor to Franklin County Tumor Registry; Vice-Chairman, Cancer Planning Committee, Metropolitan Health Council (Columbus).

On May 14, 1951, he succumbed to Hodgkin's disease in the study of which he had been a leader in research and was buried in Greenlawn Cemetery, Columbus, Ohio.

Helen Morningstar Lamborn

Dr. Helen Morningstar Lamborn, Fellow of Section C and one time Instructor of Geology at Ohio State University.

Dr. Lamborn was born in Columbus, Ohio, on September 23, 1891. She secured her Bachelor of Arts degree from Ohio State University in 1913 and a Master of Arts degree in 1915. In May, 1922, she received her Ph.D. degree from Bryn Mawr College. From 1917 to 1923 she had held the position of Instructor of Geology and Paleontology in Ohio State University and in 1920 was elected a Fellow of the Academy of Science. She married Mr. R. E. Lamborn in 1922 and became the mother of two children, Charles F. and Martha E. Lamborn. Dr. Lamborn was a member of Phi Beta Kappa, Sigma Xi, the A.A.A.S. and the Paleontological Society of America. She is the author of the following papers:

Pottsville Fauna of Ohio: Geological Survey of Ohio, Bull. 25 (1922) 312 pp., 16 plates.

Catalogue of Type Fossils in the Geological Museum at the Ohio State University: Ohio Journal of Science, vol. 24 (1924), pp. 31–63.

Dr. Lamborn died of arteriosclerosis and hypertension at Columbus on July 31, 1951, and was buried in Greenlawn Cemetery, Columbus, Ohio.

Ralph James Reynolds

Mr. Ralph James Reynolds, Attorney and member of the Bar of Franklin County, Ohio, and Fellow of the Botany Section since 1949.

Mr. Reynolds was born November 23, 1890, at Horner, Ohio, and after attending public schools entered Ohio State University and received the Bachelor of Arts degree. Later he was graduated from the Law School of the University with the LLB degree. In 1929 he married Miss Alice Fairchild and to this union were born two children, Mrs. Mary E. Reynolds Ebert and James Albert Reynolds. Mr. Reynolds was president of the Audubon Society in Columbus, President of the Bexley Garden Club, The Franklin County Garden Club Council and president-elect of the Wheaton Club. He was also a member of the American Iris Society

and the Hemerucallis Society, the National Geographic Society and the Ohio Bar Association. While professionally a lawyer Mr. Reynolds was an enthusiastic horticulturist. He died of a heart attack in Columbus on August 3, 1951, and is buried in Greenlawn Cemetery of that city.

Horace Newell Roseberry

Dr. Horace Newell Roseberry, Fellow of Section F, Professor of Physics and Head of the Department of Physics at Ohio University, Athens, Ohio.

Dr. Roseberry was born on September 3, 1904, at Prescott, Arkansas, and after securing his Bachelor of Science degree at Davidson College in 1926 and an M.A. degree in 1928, he matriculated at Chicago University and received the M.Sc. degree in 1931. He then entered Johns Hopkins University and was awarded the Ph.D. degree in physics in 1936. He served in various academic ranks as a professor of physics at the University of Virginia, 26–27; Davidson College, 27–28; Maryland, 28–36; Professor and Head of Department at College of the Ozarks, 36–37, and Professor of Physics at Ohio University from 1937 until his death.

In 1929 he married Margaret Ross and to this union were born two children, Margaret Jane and Elizabeth Ann Roseberry. He was a member of the American Physics Society, the Association of Physics Teachers, the Illuminating Engineers Society and a Fellow of the Ohio Academy. He was a specialist in the X-ray field and light and sound. He studied the effect of chemicals on X-ray lines.

Due to a toxic condition as the result of a wasp sting he developed a cerebral hemorrhage and died on October 26, 1951, at Athens and is buried in the West Union Street Cemetery of that city.

Ernest Rice Smith

Prof. Ernest Rice Smith, Fellow of Section C and one time Professor of Geology and Paleontology at DePauw University, Greencastle, Indiana.

Prof. Smith was born on July 3, 1891, at Cameron, Missouri, and secured his A.B. degree at Oberlin College in 1912 and the M.A. degree in 1919. He studied at Cornell from 1914 to 1917 and at the Sorbonne in 1919. He became Instructor in mathematics and geology in Fisk College from 1912–1914 and an assistant in geology at Cornell, 1916–17. He was petrologist for the Sinclair Oil Co. from 1917–18 and Instructor in geology at Michigan in 1919–1920, at Oberlin from 1919–1920, and Professor of Geology and Paleontology at DePauw from 1921 to 1947. He was a Goldwin Smith Scholar at Cornell and Lt. in the U. S. Army in 1918–1919, a member of the American Paleontological Society, the Crystollography Society and the Association of Petroleum Geologists. He was also a Fellow of the Geological Society of France, as well as the Ohio, Indiana and Michigan Academies of Science. He was a Trustee and Vice President of the Paleontological Research Institute, 1949–1951. He was a specialist on the Pliocene and Pleistocene paleontology, Marine Mollusca, sedimentation and physiography. He died at Ithaca, N, Y., on March 20, 1952, of heart disease and was buried at Orwell, Vermont.

Surviving him is his wife, nee' Maysie E. Summers, to whom he was married in 1918, and two children, Mrs. Elizabeth F. Smith Herdman and William Rice Smith.

Nellie Strickler

Mrs. Nellie Strickler, Member of Section A, died in Cadiz, Ohio, on March 29, 1952, of bronchopneumonia and was buried at Hilliards, Ohio.

She was born Nellie Henderson in Belmont County, Ohio, on November 30, 1885, and received her collegiate education at Ohio State University, specializing in Zoology. In 1935 she had married Mr. Strickler after many years as a science teacher in Ohio schools.

Carl Nathan Webb

Dr. Carl Nathan Webb, Fellow of Section H and Professor of Chemistry at Miami University.

Dr. Webb was born on September 11, 1900, at Montague, Michigan. He secured the Bachelor of Science degree from Northwestern University in 1925, the M.Sc. degree in 1926 and his Ph.D. degree from the same institution in 1935. In 1928 he had also earned an M.A. degree at Harvard University.

He served as instructor in chemistry at Harvard from 1927 to 1928 and from 1928 taught in the various academic ranks in the Chemistry Department at Miami University until his death, becoming Professor in 1947. In 1932 he married May Albertine Newton and to them was born one daughter, Beverly Elizabeth Webb.

Dr. Webb was a member of Phi Beta Kappa, Sigma Xi, Phi Lambda Upsilon and the American Chemical Society. His special field of study was organic chemistry. He died of coronary occlusion on December 14, 1951, and was buried at Oxford, Ohio.

Arthur Baldwin Williams

Dr. Arthur Baldwin Williams, Fellow of Section A and Education Curator of the Cleveland Museum of Natural History.

Dr. Williams was born April 11, 1874, at Montclair, New Jersey, and secured his Bachelor of Arts degree from Yale in 1898. In 1932 he was awarded the M.A. degree from Western Reserve University and the Ph.D. degree in 1935. He was the ecologist for the Cleveland Museum of Natural History from 1929 to 1939 and Curator of Education from 1939 to his death, and also a member of the Board of Managers of the Museum. He was also on the Cleveland Metropolitan Park Board and City Park Naturalist since 1943. In 1901 he married Miss Emma Hanley and to them was born one daughter, Mrs. Edwin J. Spek. Dr. Williams was a member of Sigma Xi, the American Ornithologists Union and the Ecological Society of America. He was also a Senior Fellow of the American Institute of Park Executives and The Forestry Association of Ohio, a Fellow of the Ohio Academy, and the University Club of Cleveland. He died of coronary thrombosis on August 18, 1951, and was buried at Lake View Cemetery, Cleveland, Ohio.

Ira Templin Wilson

Dr. Ira Templin Wilson, Professor of Biology at Heidelberg College and Head of the Department there—also member of the Botany Section since 1930.

Dr. Wilson was born on January 29, 1895, at Jonesboro, Indiana, and after securing his Bachelor of Arts degree at Lake Forest College he entered Indiana University and received the Ph.D. degree. He was married in 1919 to Lillian Trifford and after her decease he married Theodura Land in 1932. They had three children, Robert Quentin Wilson, Gertrude Baker Wilson and Carolyn Wilson. In 1948, Dr. Wilson was president of the American Linnologists Society and he was also a member of the American Society of Zoologists, The Indiana Academy of Science, the Sigma Xi, the American Association of University Professors, the Michigan Academy of Science, Fellow of the Ohio Academy and of the American Association for Advancement of Science. He died of rheumatic heart disease in Tiffin, Ohio, on June 11, 1951, and was buried in that city.

John J. Wolford

Dr. John J. Wolford, Associate Professor of Geology at Miami University and Fellow of the Geology Section of this Academy.

He was born near Xenia, Ohio, on November 29, 1903, and after his education in public schools entered Miami University from which he was graduated in 1926. He received the Master of Arts degree from Ohio State University in 1927 and the Ph.D. degree from Johns Hopkins University in 1932. He had joined the faculty at Miami in 1926 as assistant professor. Also in 1926 he had married Miss Vera Sturm; there is one child, Ursula Ann Wolford. Dr. Wolford was a member of Phi Beta Kappa, Sigma Gamma Epsilon and Phi Sigma societies. He was also a Fellow of the Geological Society of America; A.A.A.S.; Past Vice-President, Ohio Academy of Science and Fellow of the Association Geographical Society. He was a member of the American Society of Economic Geologists; American Petrology Association, Arctic Institute of America, and the Hawaiian Academy of Science. He was a Past Master of the Oxford Masonic Lodge, a Royal Arch Mason, the Isaac Walton League and Delta Chi Fraternity. Dr. Wolford died at Oxford on February 19, 1952, of Hodgkin's disease and was buried at South Charleston, Ohio.

A summary of this report shows that of the eleven deaths, six succumbed to heart disease, two to arteriosclerosis, two to Hodgkin's disease and one death from pneumonia. If Hodgkin's disease be considered a form of cancer of the blood then the statistics of eight deaths by cardiovascular disease and two of cancer again conform to the national mortality ratio for these diseases.

REPORT OF COMMITTEE ON RESOLUTIONS

Be it Resolved, that the members of the Ohio Academy of Science express to the faculty and administration of Kent State University their appreciation of the fine facilities furnished and the hospitality so freely extended, which have made our sixty-first annual meeting so pleasant and successful.

Be it further Resolved, that the members of the Ohio Academy of Science express their sincere appreciation to Doctor Eugene Van Cleef for his effective initiative and successful efforts in enlisting the interest and support of those corporations which have taken membership in the Academy.

Respectfully submitted,

G. B. Barbour,
A. W. Lindsey,
H. R. Eggleston, *Chairman.*

ENROLL A NEW MEMBER

The Ohio Academy of Science was organized on December 31, 1891, at Columbus, was incorporated on March 12, 1892, and became affiliated with the American Association for the Advancement of Science early in 1920. Its membership has grown from 59 charter members to more than 1200. The membership is representative of the educational and scientific institutions of the State and includes quite a number of persons outside the State.

AIMS—According to the Constitution: "The objects of this Academy shall be the promotion of scientific research and the diffusion of knowledge concerning the various departments of science." In addition to research and publication, the Academy aids in securing legislation which is favorable to scientific projects, as conservation, topographic and geologic survey, and in other important scientific projects.

MEMBERSHIP—Membership is open to all persons interested in science. Members engaged in scientific work may be elected "fellows." Each member receives *The Ohio Journal of Science* and the publications of *The Ohio Biological Survey* for the regular annual dues of $3.00. Institution and corporation memberships are also open to such organizations in the state.

SECTIONS—Each member is enrolled in *one* section for voting purposes, but is privileged to participate in the program of any section. To avoid excessive subdivision into sections as new fields of research develop, symposia which may cut across several fields of interest are scheduled at the annual meeting at hours which permit attendance of persons from various sections. Sections are listed below.

A—Zoology	E—Psychology	I —Mathematics
B—Botany	F—Physics & Astronomy	J —Science Education
C—Geology	G—Geography	K—Anthropology & Sociology
D—Medical Sciences	H—Chemistry	L—Conservation

MEETINGS—Annual meetings are held at a time and place fixed by the Executive Committee and the Council on the basis of invitations extended by educational institutions presented at the previous annual meeting. A regional plan is followed, so all areas of the state are covered over a period of several years. In addition to the program of scientific addresses and papers, field trips are frequently arranged.

OFFICIAL ORGAN—From 1892 to 1903, the *Journal of the Cincinnati Society of Natural History* and the technical series of *Bulletins of the Ohio Experiment Station* were the official organs of the Academy; in 1903 the *Ohio Naturalist* was made the official organ and continued as such until 1915 when the *Ohio Journal of Science* became the official organ. Its columns are are open to members of the Academy for special contributions, subject to acceptance by the Editorial Board. Articles in all scientific areas appear in the *Journal*.

RESEARCH FUND—From 1898 to 1922, through the generosity of M. Emerson MacMillan, of New York, a fund was available annually for encouragement of research among the Academy members. An accumulation from this grant together with the annual grant from the A.A.A.S. makes grants for research available to Academy members. This fund is administered by a committee known as the Trustees of the Research Fund.

INFORMATION—Requests for information concerning any part of the Academy program should be addressed to the Secretary, who will either send a reply or will forward the request to the proper person for reply. The current Secretary is:

DR. RUSH ELLIOTT, Ohio University, Athens, Ohio.

THE OHIO ACADEMY OF SCIENCE
(Affiliated with the A.A.A.S.) _____, 19____

I desire to become a Member of the Ohio Academy of Science. It is understood that my membership will begin immediately. Dues are attached* according to one of the following plans:

1. Application dated before July 1, $3.00 dues for current year, Jan. 1 to Dec. 31, with all copies of The Ohio Journal of Science for the year.
2. Application dated after July 1, *check one option:*
   - ☐ $3.00 dues for current year, Jan. 1 to Dec. 31, with all copies of The Ohio Journal of Science for the year; or
   - ☐ $1.50 dues for last half of current year, July 1 to Dec. 31, with copies of The Ohio Journal of Science for last six months only.
3. Corporation and Institution Memberships—$25.00 dues for the current year with copies of The Ohio Journal of Science for the year.

Name Dr. Mr. Miss Mrs. Corp. Inst. _____
(Check title preferred. Please print name)

Address _____ City _____
(Print preferred mailing address)

Institution Affiliation _____

I wish to enroll and vote in Section _____ (one section only—see above).

*Make check payable to The Ohio Academy of Science, and mail to Dr. R. M. Geist, Treasurer, Capital University, Columbus 9, Ohio.

Climate in Everyday Life. *C. E. P. Brooks.* Philosophical Library, New York. 1951. First edition. 272 pp. and appendices. $4.75.

Dr. Brooks has assembled in this volume considerable material in the relatively new field of applied climatology, a field which deals with the application of man's knowledge of climate to a better adaptation of his housing, business enterprises, and other activities, with the vagaries of weather. The primary objective of the book is to illustrate how the reader may make the best of the climate in which he lives. In a small way the author succeeds in doing this.

The publication is divided into three parts, part one dealing with climate types and the design of buildings which take advantage of favorable features of these climates especially as to the use of solar heat, and in regard to humidity and wind factors. Part two is concerned with the effect of climate on the deterioration of materials, on human comfort and health, and on the design of buildings to withstand the rigors of weather. Part three discusses man's efforts to control climate by offsetting its undesirable effects through the use of air conditioning in homes and by 'rain making' during periods of drought.

In the opinion of the reviewer *Climate In Everyday Life* will be a worthwhile addition to the reference works in climate by furnishing concrete examples for the successful application of weather knowledge to the solution of specific problems involving weather factors.

LYLE R. FLETCHER

Chemistry for the Laboratory. *Alfred B. Garrett, Joseph F. Haskins, Thor R. Rubin,* and *Frank H. Verhoek.* Ginn and Co., Boston. First edition, 1951. xi+355 pp. $3.00.

The number of General Chemistry Laboratory manuals published during the past ten years is so great that each new one is likely to be considered "just another laboratory manual." This manual should not be so classified. It has a definite appeal from the purely mechanical viewpoint. The use of heavy black type for sub-headings is very effective. The numerous illustrations stand out clearly because they are drawn in perspective. The sheets are perforated for easy removal and punched to permit reassembling as corrected experiments are returned.

The appendices provide much useful information for the student, instructor, and stockroom manager. The section on arithmetic in chemistry is well done but would be more valuable if additional problem types had been included. Emphasis on oxidation and reduction and inclusion of exercises on "The Electrons in the Atom" and "Radioactivity" indicate consistency with modern trends in the teaching of chemistry. The authors have shown commendable restraint in limiting the number of questions which are well chosen and clearly stated. The small number of questions with obvious answers is refreshing. The number and variety of experiments allows considerable latitude in selecting experiments to fit a given situation.

The authors have succeeded rather well in their attempt to produce a coordinated unit for the study of chemistry in the laboratory. Despite several sad experiences with manuals that "looked good" but proved unsatisfactory in actual use, this reviewer believes that "Chemistry for the Laboratory" can be highly recommended.

NELSON W. HOVEY

Principles of Geology. *James Gilluly, Aaron C. Waters, A. O. Woodford.* W. H. Freeman and Company, San Francisco. First edition, 1951. xiii+631 pp. $5.75.

In the reviewer's opinion the authors have taken an interesting and unique approach, which departs from the usual practice in the study of geology. The brief treatment of conventional topics and terms allows for more emphasis on the kind of evidence on which geologic conclusions are based, for example, the Pratt or Airy Theory of Isostasy; Newton's Law of Gravitation; Darcy's Law, as applied to ground water movement; various theories on mountain building; etc. This is done quite consistently throughout the text. The introduction of engineering problems in gravity movements of soil and rock, ground water supplies as it affects various groups of people in their daily living, effects of earthquakes upon man in inhabited regions; and other practical applications also add greatly to the use of the text.

A very commendable feature is the wealth of profiles and diagrammatic sections used to illustrate text content. Practically all of the twenty chapters include a summary of "Facts Concepts, Terms" with a list of basic questions and "Suggested Readings." Four appendices, Techniques of Topographic Mapping, International Atomic Weights, Identification of Minerals, and Identification of Rocks follow the text material.

The author attains the objectives which appear in the preface. The text is quite readable, attractively printed and bound, supplemented by many excellent pictures, and challenging to the reader. Such a well-balanced book should meet the demands for a college text in physical geology.

HARRY K. HUTTER

R. H. BURTON COMPANY
can fill your optical needs

☆

E. LEITZ MICROSCOPES
Franchised Dealer
MICROSCOPE REPAIRING
. . . All Types
Authorized by American Optical Company
BINOCULAR REPAIRING
. . . All Makes
Authorized by Leading Manufacturers

BINOCULARS FOR SALE
AUTHORIZED DEALERS
D. P. BUSHNELL
and
BAUSCH & LOMB

Pick-up and Delivery Service

R. H. BURTON COMPANY
2504 Sullivant Avenue
COLUMBUS, OHIO
RAndolph 5472

There's Still Time To
PREPARE YOURSELF
For a Profitable Summer of
FIELD COLLECTING

GEOLOGISTS, MINERALOLOGISTS
. . . write for "Supplies and Equipment for the Geologist."

ENTOMOLOGISTS, BIOLOGISTS
. . . write for Ward's Biological Equipment Catalog #495g.

WARD'S NATURAL SCIENCE ESTABLISHMENT, INC.
P. O. Box 24, Beechwood Station, Rochester, N.Y.

Good Buy — MICROSCOPE SLIDES

Microscope slides have risen in cost less than any other laboratory equipment

Best Buy—TRIARCH SLIDES!

1. Triarch selects for uniform quality.
2. Triarch ships all slides on approval, with speed and accuracy.
3. Triarch absorbs all shipping costs: our catalog price is the price you pay.

FOR CATALOG
WRITE: GEO. H. CONANT
TRIARCH PRODUCTS
RIPON, WISCONSIN